ELECTRONICS Australia

HIFI NEWS

JUNE, 1974
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SPECIAL CALCULATOR OFFER

STARTING: A NEW SERIES ON FM RADIO

DESIGN FOR A COLOUR TELEVISION DECODER

ECONOMY IC STEREO AMPLIFIER PROJECT

THIS SUPERLATIVE MUSIC SYSTEM IS ALL-SONY. IDEALLY.

So many hi-fi 'systems' are a weird mixture of various brand name components. Sony's Taurus music system is all Sony. And it combines high efficiency components superlatively *matched* for value and reliability that equals their outstanding sound. And remember, no other company gives such a comprehensive and complete guarantee— 12 months on all parts. Complete price: $539.*

Here are the individual Sony units of the Taurus system . . .
Sony's exciting TA-1055 amplifier packs 23W RMS per channel into its gleaming chassis. It offers wider power bandwidth, and, because of direct coupled power amplifier, gives low distortion, high stability and excellent transient response. Input and output facilities for two tape recorders makes inter-recording dubbing possible. Latest push button and slide controls.

Sony's elegant PS-5100 turntable gives outstanding reproduction of the finest stereo records for both audiophiles and newcomers to hi-fi. Features aluminium diecast platter and high quality 4-pole hysteresis synchronous motor, automatic arm return, reject device, special damping device prevents pick-up damage, balanced tone-arm anti-skate device, and induced-type magnetic cartridge. All in a timber cabinet with plastic dust cover which can be left open at any angle.

Sony's stylish SS-7100 speaker enclosure are a high compact 2-way, 2-speaker system with 20 cm woofer and 2.5 cm dome tweeter. Features Sony's exclusive Ultra Linear Magnetic Path for smooth, clean sound and greatly reduced harmonic distortion.

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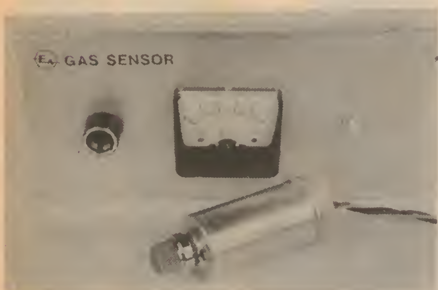
VOLUME 36 No 3



Build this electronic gas detector and use it to check car exhausts, boat bilges and for other applications. It can even be used as a breathalyser! Low in cost and easy to build, you'll find it described on page 49.

Digital television: does it hold the key to the future as far as video is concerned? Our story beginning on page 36 explains what it is, and the advantages it offers.

On the cover

The model is holding one of the Rodan 80N calculators which are being offered to E-A readers at a special price by the Professional Components department of Plessey Ducon Pty Ltd. Full details of the calculator and the special offer are given on pages 40 and 41 of this issue. (Picture courtesy Plessey Ducon.)

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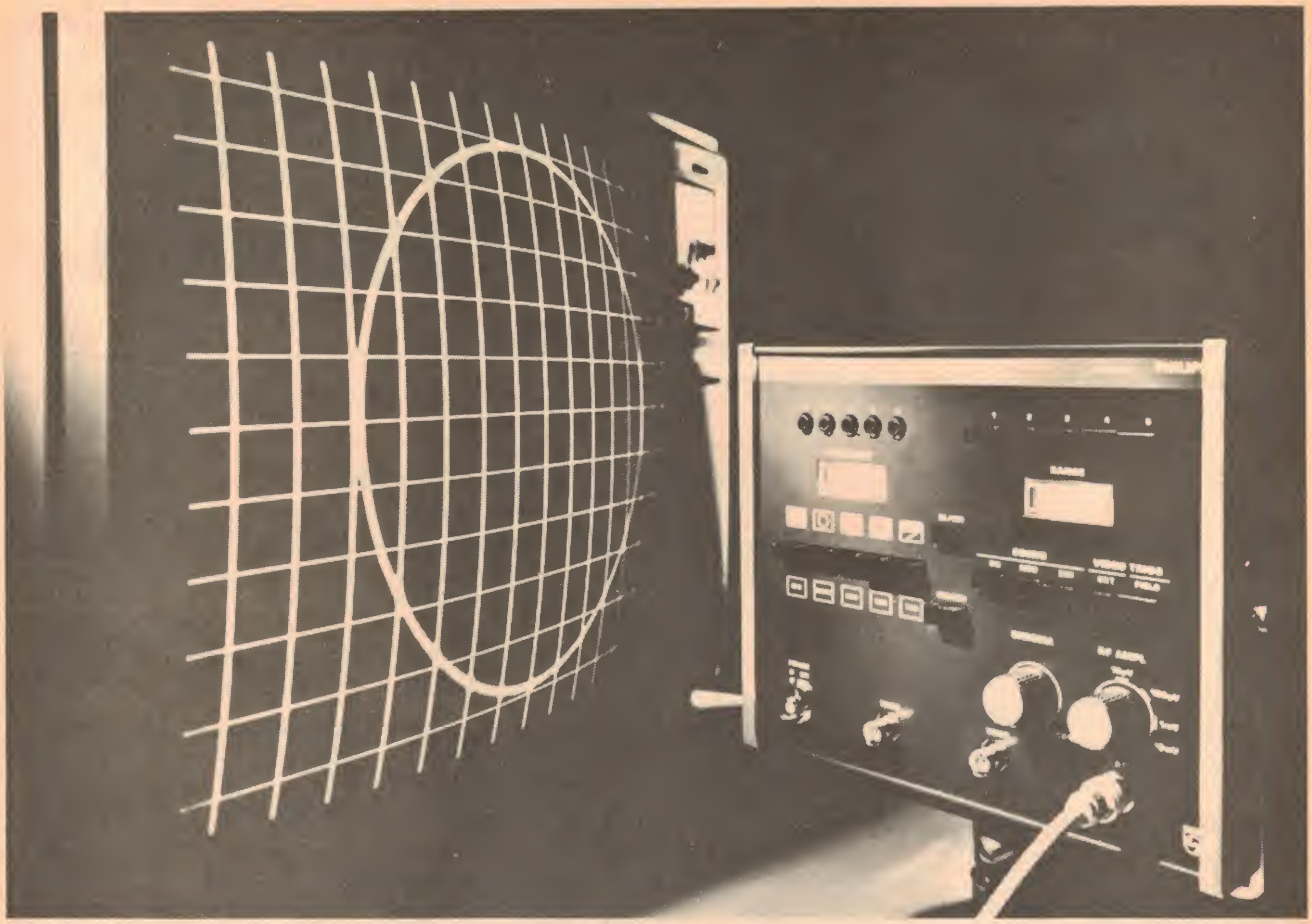

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Philips have more than 30 years' experience in colour TV research, development and manufacture, leading to our present position as the largest manufacturer of colour TV sets in Europe—the home of PAL. We are the world's largest manufacturer of both black/white and colour picture tubes and we are the world leaders in colour picture quality. Hence our experience and pride in our range of CTV test instruments.

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PHILIPS

Editorial Viewpoint

Reflection on the tariff decision

Last November when the Labor Federal Government announced its decision to cut import tariffs on electronic equipment and components, there were dire predictions from representatives of local industry, particularly those representing component manufacturers. Almost to a man, they forecast the imminent demise of local component manufacture, and a serious contraction in the operation of local equipment assemblers.

But at the time, the public mood was one of optimism, and it was easy to discount these predictions. The Tariff Board had carried out extensive investigations, and in their report (which recommended lower tariff levels than were actually set) asserted that the industry as a whole would not suffer. If this was so, then presumably it would be even less embarrassed by the levels finally set . . .

There was a spirit of revolution in the air, and even some within the electronics industry were prepared to admit that the entrenched manufacturers might have grown fat and inefficient under the previous higher level of protection. Perhaps the reduction in tariffs would ginger us all up, and bring about a worthwhile improvement in productivity and efficienty. Sure, some were predicting doom, but these were probably only spokesmen for the vested interests; things would never be as serious as they were predicting.

The main idea seemed to be that Australian consumers would be able to buy colour TV sets and other domestic equipment at the lowest possible prices. If this meant that we lost our component manufacturing industry, it was sad but unavoidable.

Whether one agrees with this reasoning or not, it certainly seems that the predictions were right concerning component manufacture. In the months since the decision was made, the closure of local component manufacturing lines has been an almost weekly occurrence. There is now virtually no local manufacture of resistors or capacitors, and before long it seems likely that there will be minimal manufacture of ICs and discrete transistors.

But perhaps the most disturbing aspect of the situation is that with no difference in tariff between components and equipment, there is little motivation for local equipment manufacturers to take advantage of low cost imported components. This together with the lack of any positive action by the Government on subsidy assistance or procurement offsetting seems to be responsible for a growing spirit of defeatism, not just in the component sector but among erstwhile equipment manufacturers as well.

Assuming we want an electronics industry consisting of more than pure importers, it seems to me that urgent Government action is needed. If this is delayed too long, the rot may really set in.

—Jamieson Rowe

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Now, a speaker so good it invites any comparison

The Plessey C80X wide-range hi-fi speaker. Built to the most exacting standards to provide superior performance under all conditions and now incorporating Plessey's advanced CFL cones, the C80X is now endowed with the exceptional sound reproduction characteristics required by the serious audio enthusiast.

FEATURES

CFL — Controlled fibre length cones provide improved frequency response and efficiency under the highest loadings.
Large 'O' magnet gives 20 watts RMS power handling in recommended enclosures and lower 'Q' for cleaner bass. Long throw voice coil allows extreme excursion with minimum distortion.
Infinite baffle response is 35 Hz to 20 kHz.
In the recommended 1.8 cu. ft. enclosure it is 54 Hz to 20 kHz ± 6 dB and 41 Hz to 20 kHz at ± 10 dB. The high frequency response is a particularly outstanding feature in such a rugged speaker capable of 20 watts RMS power handling.

SPECIFICATIONS

Power handling capacity	20 watts RMS in recommended enclosure
Fundamental resonance	45 Hz nominal
Voice coil diameter	1"
Voice coil impedance	8 or 15 ohms
Frequency response	35 Hz to 20 kHz ± 6 dB
Total Q	0.5
Volume equivalent to loudspeaker compliance	4500 cu. in.
Air gap flux density	1.15 tesla
Total gap flux	455 μ weber

** A woofer version, C80, is also available. Frequency response is 35 Hz to 8 kHz ± 6 dB.*

* with Plessey controlled fibre length cone

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AR63

Hi Fi News

Idea for synthetic treble response

Engineers in Germany have come up with a method which may effectively double the audio bandwidth of systems which currently suffer from inherent limitations. Super-8 sound projectors and AM broadcast receivers are obvious candidates for such possible assistance, which would be aimed at extending the effective treble response to about 10kHz.

The dramatic fall in the cost of integrated circuits has produced a welter of new ideas for improving the quality of radio, tape, and film sound tracks.

A technique that can almost double the quality of the speech and music transmitted over any given channel will soon reach the marketplace.

This particular technique, known as Picor and which has been developed by the ITT components group laboratories in Esslingen near Stuttgart, makes use of the fact that people cannot determine with any accuracy the pitch of high frequency notes, and this applies even to musicians of great skill.

The basic physiological effect is well known. ITT engineers have put it to good use by first of all carrying out exhaustive tests on themselves and other people. These showed that once the frequency becomes greater than some limit between 4.5 and 6 kilohertz it is impossible to recognise a wrong note provided it deviates from the correct one by not more than two semitones.

There are several ways of exploiting these findings. They all involve the transmission in full of only those frequencies below the limiting one. Frequencies above it are sent only in a coded form and are reproduced in the receiving equipment in the form of a note of the correct amplitude but of only approximately the correct frequency.

In the medium frequency radio band, for example, the highest frequency that can be transmitted is normally 4.5 kilohertz, but if the transmitter and receivers are fitted with Picor this can be extended to 9 kilohertz. All frequencies up to 4.5 kilohertz are transmitted in the usual way. The frequency range between 4.5 and 9 kilohertz is divided into 12 separate channels and the amplitude of the notes in each of these channels is sampled sequentially. The amplitude values derived in this way modulate in turn a pilot carrier on a frequency just above 4.5 kilohertz.

In the receiver, the band up to 4.5 kilohertz is handled as in conventional receivers. The pilot is demodulated and used to control the amplitude of tones generated on frequencies in the middle of each of the 12 channels sampled in the transmitter.

The composite signal fed to the loudspeaker thus consists of all frequencies up to 4.5 kilohertz plus a series of spaced tones each having the same amplitude as the tones in the corresponding channel in the studio but deviating in frequency from the original tones by anything up to two semitones. The overall effect is remarkably good.

The pilot carrier, which is 20dB lower in amplitude than the normally transmitted frequencies, is inaudible thanks to the physiological effect known as masking, as the result of which a single tone close to a higher amplitude band of frequencies is undetectable.

Improving the quality of speech is a somewhat more complex operation, particularly in the case of people with hoarse voices.

The artificially produced tones in the receiver have to be augmented with locally generated noise which has to be proportional in amplitude to the speech frequencies in the equivalent channel.

The whole process may seem like getting something for nothing, but what in effect is happening is that the transmitted information is being strictly limited to that which can be used by the listener's hearing apparatus and brain. In this way the amplitude modulated pilot carrier, which occupies a bandwidth of only 600 hertz, carries all the useful information contained in the top half of the band of frequencies being handled.

The first application of the Picor system will be on Super-8 film optical sound tracks. These have a physically limited bandwidth of only 5 to 6 kilohertz. Next year, a German company will be using Picor to double the quality of the sound on the Super-8 film equipment it manufactures.

After that, ITT sees the improvement of quality on medium frequency AM radio as being the most important application. This will provide virtually hi-fi quality over long ranges, and for motorists for the first time.

There is a great deal of interest in long distance application in Germany. ITT talks about providing a service for German tourists in places like Yugoslavia, but there is reason to believe that there is also a long-term West German interest in attracting listeners in the German Democratic Republic.

Picor is also likely to be used over the telephone network, initially to improve the quality of reports and commentaries sent by radio and TV journalists. In the long term it may also provide a means of significantly improving the quality of all telephone conversations.

(From "New Scientist")

Unconventional styling for Lecson audio range

The unconventional styling is clearly illustrated by the cylindrical power amplifier at right and the slim profile of the preamplifier.

Magnecord International Pty Ltd, 276 Castlereagh St, Sydney, have recently announced their appointment as Australian agents for the Lecson high quality audio equipment range from the United Kingdom.

The new range, featuring an unusual design approach and boasting impressive performance specifications, includes the Lecson control unit (AC1), two audio power amplifiers (the AP1 and the AP2), and FM tuner (TF1), and horn loaded 3-way speaker system.

The AC1 control unit features a comprehensive range of input and control facilities, including tape monitoring, and has a claimed distortion level of less than 0.05pc at all times and a frequency response of 10Hz-25kHz plus or minus 0.5dB. An additional unit enables the control unit to be remotely controlled for input switching and volume setting.

Intended for use with the AC1 control unit, the AP1 and AP2 power amplifiers are rated at 35W and 70W RMS per channel respectively. Distortion is claimed to be less than 0.05pc at all frequencies and power levels up to 35W.

Apollo Hi-Fi at the Sydney Royal Easter Show

Just a few hours before the Sydney Royal Easter Show was due to open, Apollo Hi-Fi of Marrickville, NSW, was invited to occupy a stand that had quite unexpectedly fallen vacant.

Apollo manager Mel Chillari didn't exactly relish the idea of setting up a display in about four hours flat but he realised that it could be a worthwhile effort, seeing that Apollo would probably be the only hifi retailer on the site.

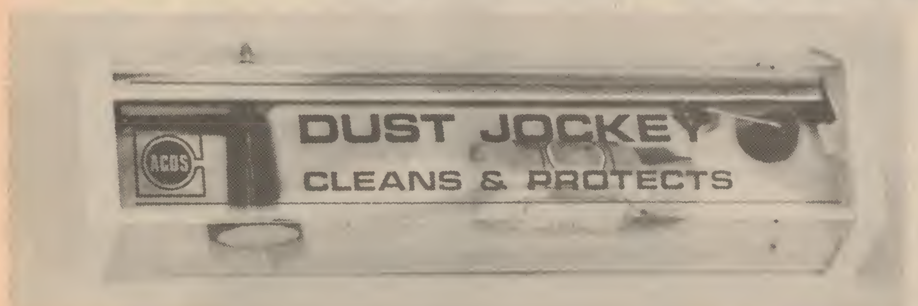
And that's how it turned out. According to Mel Chillari, public response to the display more than justified the effort involved.

A general view of the stand is shown top right while, at the lower left, Rudy Hollander explains what all the knobs are for, and the exposed "works" of a couple of multi-speaker systems.

And speaking of exposed works, an obvious question arises about the eight loudspeakers facing this way and that in the adjacent picture. The eight loudspeakers, we discovered, occupy the rear face of a new system designed along similar lines to the Bose 901, featured in our March issue. There is a ninth loudspeaker facing the front. Apollo aren't saying too much about the brand yet, but hope to retail the new system at $495 per pair. Power rating is quoted as: "from 5 to 200W each" and frequency response: "20Hz to 20kHz."

(Apollo Hi-Fi is at 283 Victoria Rd, Marrickville, 2204. Tel.: Sydney 560 9019).

ACOS Dust Jockey combats clicks and plops



One of the accepted methods of combating dust particles on disc recordings is by "playing" the discs simultaneously with a second arm carrying a small brush and a slightly moistened pad. If the pad and brush track the record at the same rate as the pickup, and straddle the track being played, there is a good chance that they will collect dust particles before the stylus has a chance to ride over them and produce "pops" in the output.

Probably the best known of these devices was the original "Dust Bug" which appeared on the market many years ago. Since then a whole array of similar devices have made their appearance, some simple and functional, others quite expensively presented.

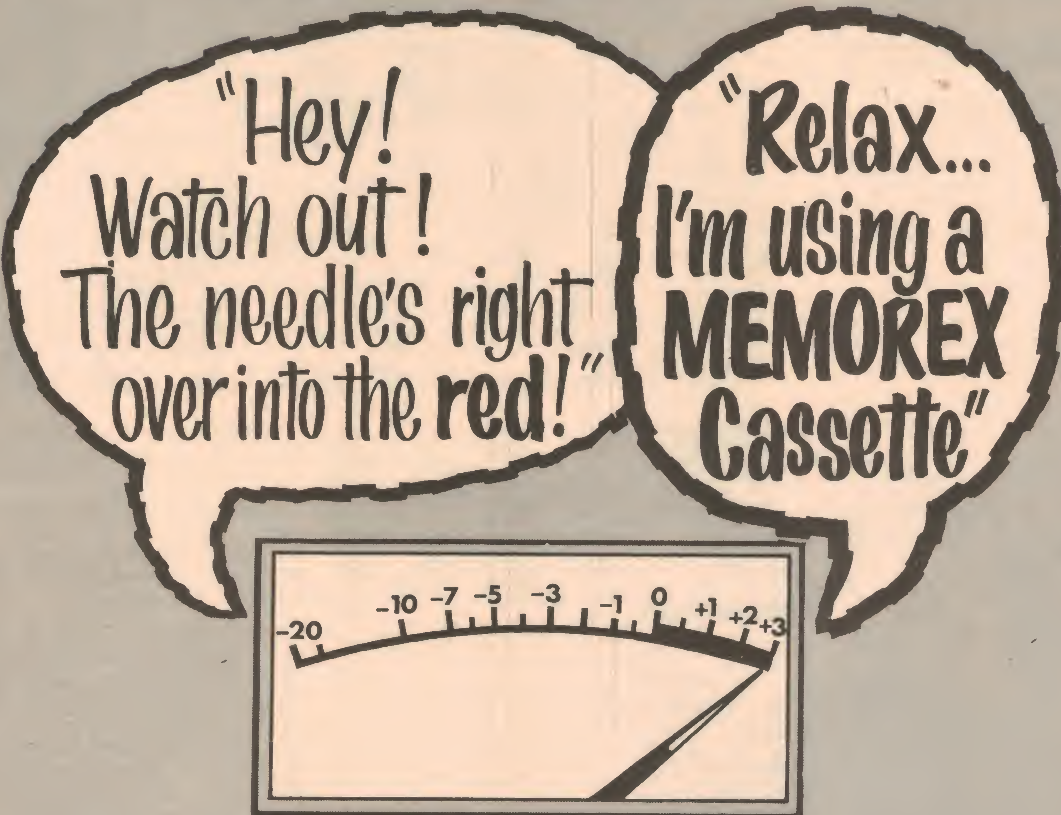
Among the "simple and functional" units is one manufactured by Cosmocord Ltd under the Acos brand, and marketed in this country by McMurdo (Australia) Pty Ltd, of 346-8 Carinish Rd, Clayton, Vic 3166; also 219 Blaxland Rd, Ryde NSW 2112.

The Acos "Dust Jockey" involves a simple matte aluminium arm, on a moulded base with a self-adhesive pad on the underside. It is intended to adhere to any smooth surface, without defacing it. While this will suit most installations, neither self-adhesive nor suction cup devices will attach reliably to some rough finishes and this should be borne in mind before purchase. It may, of course, be possible to anchor a small scrap of perspex adjacent to the turntable on which the Dust Jockey can rest.

Instructions on the underside of the pack explain how the Dust Jockey should be installed to ensure proper tracking. When not in use, it is supported out of the way by a bracket attached to the base, which engages the overhang of the arm. The pack as illustrated contains a small bottle of fluid to keep the pad very slightly moist.

The Dust Jockey is competitively priced but does not have a "recommended retail" figure. Actual selling price will depend completely on the retailers quantity discount and mark-up.

The Acid Test.



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THE UNDISTORTER!

For the very first time you can forget about overload distortion when you record. Just use 'Memorex' the Undistorter. No hiss, no distortion, no hassle, just beautiful clean clear sound. And Memorex costs only cents more than the cheapies.

You'll never know how good your recorder is until you try 'Memorex' tape.

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LERO 56

HIFI NEWS

3 New Pioneer Decks

Pioneer have launched a strong assault on the highly competitive cassette deck market with three new models which include a top quality "Dolby" model with an array of features, a less expensive Dolby model, and a high quality "straight" deck. Replacing two earlier decks, the three new models carry a full warranty covering parts and labour costs for one year.

Above: Top of the new line of Pioneer cassette decks, the CT-5151, boasts virtually all the facilities offered in such equipment. The CT-4141A is very similar in appearance and is tipped to be the "big seller".

At left, the CT-313A has similar styling but fewer facilities.

Top of the line in the new series is the CT-5151, which has a recommended retail price of $349. In line with modern practice, the CT-5151 has an electronically speed controlled motor, full automatic stop protection, "ferrite solid" erase and record / playback heads, and a counter with associated memory function. Other mechanical features include a tape-run indicator and a skip button which permits the user more easily to locate a particular item on the tape.

Electrically, the design provides for input and output faders, and provision for phones, microphones, and easy interconnection with an amplifier system. The bias and equalisation can be set separately to suit standard or chromium dioxide tape, while two meters and a peak indicator LED allow very accurate setting of the record level.

Wow and flutter is quoted as less than 0.12% RMS; frequency response as 63-12000Hz with standard tape, or to 13,000Hz with CR02 tape, both figures for plus and minus 3dB. Signal / noise ratio is given as 48dB with standard tape or 58dB with Dolby in operation.

In many respects, the CT-4141A resembles the more expensive deck, but it does lack the more fancy facilities such as memory type counter, automatic limiter and Dolby indicator lights. The record / playback head is "permalloy solid" rather than "ferrite solid," and the frequency response figures are marginally poorer at the extreme treble. But, while a second look and a second listen may be necessary to distinguish the two machines, one could hardly miss the price difference: $279 against $349!

While the CT-3131A is obviously a member of the same design family, it has been further simplified with respect to the CT-4141A by the omission of the Dolby facility and the "skip" button. The deck will still accommodate CRO2 tape however, a push-button effecting the necessary change in bias and equalisation. With one ferrite and one permalloy-solid head, electrical performance is generally similar to that of the CT-4141A. But, again, there is the expected significant difference in price: $29.

Further information on the equipment can be obtained from Pioneer Electronics Australia Pty Ltd, 256-8 City Rd, South Melbourne, 3205. Branches also in Sydney, Perth, Adelaide, Brisbane.

Cassette measures torque

United Electronic Servicing Pty Ltd, "the Service Company for Philips and Astor Household Products," have a number of test cassettes available intended to facilitate professional servicing of cassette record and replay equipment.

One of the most interesting items, as pictured, is the 811 / TCM cassette torque meter. Housed in a clear plastic case, of standard cassette dimensions, the torque meter can be inserted directly into a recorder / player and contains sufficient tape for a 3-minute traverse at normal speed.

While operating, pointers on the respective spools indicate the winding friction of torque on the right hand take-up spool and the counter winding friction or torque on the left hand supply spool. The scales are calibrated to 120 g-cm and the makers claim an effective accuracy of 1.5%.

Armed with this information, a service technician can adjust the mechanism so that the torque figures actually shown correspond with good practice, or with specific values where these are quoted in service data for a particular machine.

While the cassette torque meter can be used directly in a machine without dismantling and under fully dynamic conditions, the values are indicated on rotating spools and some care has to be exercised in reading them.

Trade price for the torque meter is quoted as $35.20 plus 15% tax.

The cassette torque meter, pictured above slips into position as a normal cassette. It registers torque as it rotates.

In addition to the torque cassette, the company literature indicates the availability of a number of tests tapes as under: TC-R, test cassette reference tape; TC-A6.3, test cassette azimuth 6300Hz; TC-FL3, test cassette flutter 3000Hz; TC-S test cassette service; TC-A10, test cassette azimuth 10kHz; TC-FR test cassette frequency response; TC-FL3.15, test cassette flutter 3150kHz; TC-CT, test cassette crosstalk.

For further information: United Electronic Servicing Pty Ltd, 443 Concord Rd, Rhodes, NSW 2138.

TEL-14/TWO-WAY
$29.95

TEL-26 DYNAMIC $36.95

TEL-29/LIGHTWEIGHT $19.95

TEL-111/ELECTRET $85.00

TEL-32Q/QUAD,
4-CHANNEL
$66.00

There's a new name for Stereo & Quad Headphones: Telephonics

A leading designer and manufacturer of quality audio products for 40 years, Telephonics now introduces a complete line of Stereo & Quad Headphones. The same high reliability required for airline entertainment and communications systems is now made available by Telephonics, for home and professional use.

The TEL-111 ELECTRET Headphone, for example, incorporates the latest advances in electrostatic audio reproduction providing flat frequency response from 18 to 24,000 Hz, without the need for the conventional electrostatic power supply. And it reduces distortion to the vanishing point by using a stiff featherlight diaphragm suspended between two permanently-charged plates. The result is the clean, crisp, Telephonics sound, unobtainable with any but the most expensive speaker systems.

The TEL-26 DYNAMIC Stereo Headphone reproduces sound so faithfully that once you hear it, you'll never be satisfied with anything less. It has a separate tone control and volume control on each earcup to permit precise volume, balance and tone adjustments. And Telephonics mechanical 2-way speaker system gives you the 2-way sound without the cost.

For the breathtaking realism of quadraphonic sound, the TEL-32Q QUAD, 4-CHANNEL Headphone has two 2-way speaker systems (four speakers in each earcup) to let you discover sound you've never heard before. The Telephonics Balance Controller lets you sit in your favorite easy chair, far from your receiver or amplifier, and set the 4-channel balance exactly the way you want it.

The TEL-14 TWO-WAY Headphone contains a full 2-way speaker system, complete with crossover network in each earcup. Deep, smooth bass response from the woofers and the bright treble highlights of the tweeters overlap to make the presence of the music felt, just the way the artist intended.

The TEL-29 LIGHTWEIGHT Headphone, the "Weight Watcher" member of the family is easy on the budget. Constructed of air-light materials for hours of easy listening, the Lightweight never disturbs nor intrudes on the music, but is not completely isolating. A volume control on each earcup allows you to adjust volume and balance without returning to your amplifier.

If you want to hear Sound the way it was recorded, don't let an ordinary Headphone come between you and your music. Demand the exceptional. Ask for Telephonics.

Telephonics

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A Division of Instrument Systems Corporation

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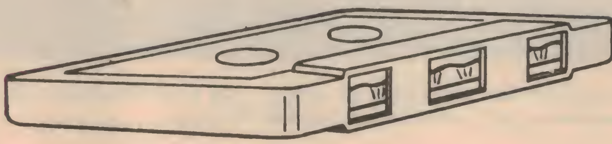
More about those bargain cassettes



In our April issue, we had something to say about bargain cassettes and their place in the scheme of things. Our reservations had mainly to do with fairly obvious properties: either mechanical failure or limited frequency response.

Mechanical failure leaves little room for doubt; you just don't buy for a second time a type of cassette which tends to jam, or to wind around the capstan. Poor frequency response is something different; for speech or casual recording, you may decide that a certain cheap tape is good enough.

Since writing these paragraphs, we've come across a crop of tapes which exhibit quite another type of fault: they may record perfectly on one pair of stereo tracks but not on the other. The sound wavers up and down in level, with an admixture of distortion for additional effect!

Close inspection will generally reveal the cause of the trouble. Hold the cassette away from you and look along the surface of the tape against a light. One edge, or in some cases both edges, will be seen to be buckled, with a pitch of 2 or 3cm.

Fairly obviously the slitting blades have not been sharp, or properly set, and the particular edge of the tape has been stretched. The pressure pad in the cassette is simply not stout enough to flatten the buckles and the tape periodically contacts and leaves the gap as it passes across it.

The effect may be tolerable, in some cases, on a mono machine, since only part of the total track may be affected. But on stereo, the outer track may be completely "modulated".

Most of the offending cassettes we have noticed have been "bargains" from Britain or the Continent but, in one case at least, we encountered the trouble with a prestige brand.

At the very least, the lesson seems to be: If you buy a bargain cassette, turn it far enough to expose the magnetic tape and then sight along it. If the tape shows any sign of edge buckle, hand it back!

To balance these rather critical remarks, we should perhaps add that some cassettes we have seen around the shops have been real bargains — very reliable, very smooth and with good frequency response.

SONY PRODUCTS

Since April 1, the Australian distribution of Sony audio and video products have been handled by Sony Kemtron Pty Ltd and Sony Kemtron Services Pty Ltd.

These companies, in which Sony Corporation of Japan and Kemtron Limited are equal shareholders, have taken over all assets, existing premises, and staff of Jacoby Kempthorne Pty Ltd and Jacoby Kempthorne Services Pty Ltd.

Directors are Messrs Andrew Grimwade and J. H. Went on behalf of Kemtron Limited and Messrs A. Endo and P. H. Jacoby (Chairman & Chief Executive) representing the Sony Corporation.

SANSUI TURNTABLE

Sansui Electric of Tokyo is launching a new medium-priced turntable in Australia after requests from dealers for an economical, quality turntable to complete its audio component range. Called the SR-212, the new turntable will be marketed through the Consumer Division of Rank Industries Australia selling at around $179.

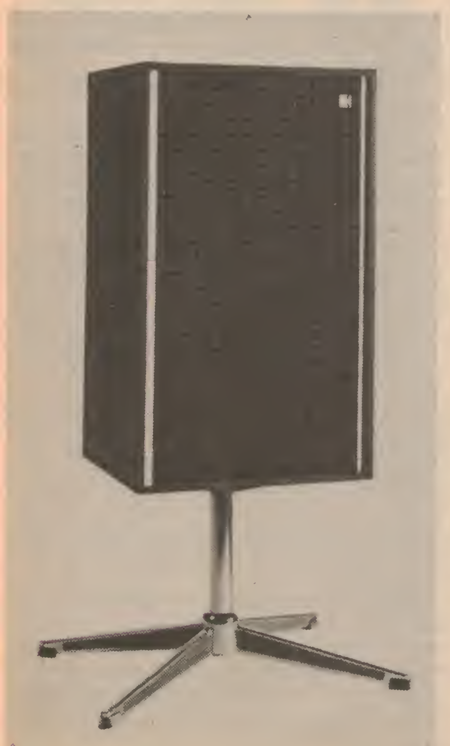
Sansui claims a frequency response from 20 to 20,000Hz and a signal to noise ratio of better than 45dB. It features a four-pole

synchronous motor, 30cm diameter die-cast alloy platter, belt drive and S-shape tone-arm with automatic cut and return mechanism.

The auto-return mechanism lifts the stylus when it reaches the lead-out groove of the record and returns to the rest switching off power at the same time. It can also be used to stop the record at any point.

The tone-arm has a direct-readout stylus pressure scale, anti-skating device and is fitted with an IM (induced magnet) cartridge.

New KEF loudspeaker from Interson



Latest addition to the KEF range of loudspeakers in Australia is the "Cadenza", pictured at left, a full range unit, which can be used on a shelf, or free standing, or on a tripod stand, as shown.

The Cadenza measures approximately 60 x 36 x 30 cm and, as such, may be regarded as a generously proportioned shelf unit or a compact, free-standing system. But the manufacturers claim that it is a genuine full-range design, comparable in sound with larger systems.

Main driver in the Cadenza is an 8-inch unit with a 2-layer laminated "acoustilene" diaphragm. This is intended to handle directly frequencies between 70 and 3500Hz. Below 70Hz, a 33 x 23 cm passive radiator radiates most of the low frequency energy extending the response down to a claimed 30Hz.

For the upper register, the Cadenza uses a 2.5 cm dome tweeter with Melinex diaphragm, ensuring uniform dispersion of sound over a wide area. Recommended retail price of the Cadenza is $170 per system, the stand being extra — and recommended.

Weight is 15.5kg, power rating 25W nominal, impedance 8 ohms and frequency response 30-30,000Hz. (Further details are available from Interson Pty Ltd, 64 Winbourne Rd, Brookvale, NSW.

HiFi-Stereo Annual

The 1974 Electronics Australia "HiFi-Stereo Annual" is virtually a complete, easy-to-read course on hifi, all the way from basics to modern 4-channel sound. It is available from newsagents for $1.50 or from our office for $1.90 posted. (Box 163, Beaconsfield, NSW 2014.)

In conformity with European styling, this slim Armstrong series 600 receiver / amplifier features a high performance stereo FM tuner.

FREQUENCY MODULATION...

For noise-free wide-range stereo radio

It is now virtually certain that Australia will have a new FM / stereo broadcast service on VHF. But what is FM, FM / stereo, and VHF? In this, the first of a planned series of articles on the FM technology, we seek to answer these and other questions —without using too much technical jargon!

by NEVILLE WILLIAMS

As a starting point for the discussion, we are concerned with two fundamental aspects of radio transmission and reception.

The first is the production of a basic high frequency signal, which can be radiated from a transmitting antenna, can travel through free space, be intercepted by a receiving antenna and fed into a radio receiver. This high frequency signal is commonly referred to as the "carrier" because it provides the means by which some kind of information can ultimately be transferred from one place to another.

Carrier frequencies as low as about 10kHz (10,000 cycles per second) are used for special purposes, notably for communication with submerged submarines.

"Medium-wave" broadcasting stations, with which we are all familiar, operate with carrier frequencies in the approximate range 525kHz to 1600kHz.

What we refer to as "shortwave" stations operate on frequencies between about 3MHz and 30MHz, being referred to alternatively as HF (high frequency) stations.

Australian television stations operate in the VHF (very high frequency) part of the spectrum, between 30MHz and 300MHz.

Above that again is the UHF (ultra-higher frequency) region, and this is as far as we need to consider for this present discussion.

Transmission of a pure carrier wave would be an interesting but rather futile exercise, since it conveys little to the recipient beyond the fact that it is being transmitted. If it is to convey information beyond that, the carrier must be varied or "modulated" in a logical way so that the variations can be detected or "demodulated" at the receiving end and the information extracted.

The most elementary method of modulating a radio frequency carrier is to switch it on and off according to a particular code, which can be interpreted at the receiving end. This is the basis of the well known Morse Code.

Because Morse Code is often initiated by means of a hand-operated "key", it is sometimes referred to by the whimsical name "dexterity modulation".

Morse and other similar codes have provided a quite classical means of basic communication, but not by any stretch of the imagination can they be regarded as potential entertainment. For radio (or "wireless" as it was then called) to have any use or appeal to the population at large, engineers had to devise a means of modulating the carrier with electrical signals derived directly from speech and music.

A speech- (or music-) modulated carrier could thus be transmitted or broadcast to remote points, picked up and fed into receivers, demodulated, and the information made audible through headphones or loudspeakers.

Very early, it was realised that sound derived signals could be made to affect a carrier in either of two fairly obvious ways:

AMPLITUDE MODULATION: In this system, the information or audio signal voltage is so applied in the transmitter that the strength (or amplitude) of the carrier varies instantaneously with the audio voltage. The carrier frequency remains unaltered. A carrier is said to be fully amplitude modulated when the applied audio voltage causes it to vary from double its normal amplitude to near zero.

FREQUENCY MODULATION: In this system, the audio voltage is so applied in the transmitter that it causes the frequency of the carrier to vary above and below its nominal position in the spectrum. The rate of variation depends on the modulating frequency, while the amount of variation is governed by the strength of the modulating frequency and by adjustment of the transmitter controls. While the frequency of the carrier thus varies, its amplitude remains constant.

In the early days of radio broadcasting, amplitude modulation was considered to be the most practical system, being the one for example which best suited the receiver detectors of the day. For this and other reasons, practically all early development centred around AM (amplitude modulation) and it became the standard method for virtually all radio communication and broadcasting systems.

Even now, all ordinary medium-wave broadcasting stations throughout the world use the AM system, as do international short-wave stations.

While this is so, the AM system is by no means above criticism.

An AM receiver and, in particular, an AM detector is basically sensitive to any change in voltage amplitude, whether the change is produced by the wanted incoming signal, or by some less welcome phenomenon.

And here's the rub: electrical disturbances caused by atmospheric conditions, and also by man-made electrical circuits tend to produce just this kind of voltage change at the receiver input, and consequent "noise" of one kind or another at the output.

In short, by its very nature, an AM receiver is prone to interference from both atmospheric and man-made sources. Atmospheric "static" has long been the bugbear of listeners in remote country areas; electrical interference is all too familiar to suburban dwellers, living within a virtual maze of electrical wiring and equipment.

While it is possible to alleviate such problems by providing more powerful transmitters, by siting transmitters in local communities, and by circuit tricks in the receiver, all such measures have practical limits. In Australia, as in many other areas, the stage has been reached where it is difficult to accommodate more stations, or

more powerful stations in the normal AM broadcast band, without running into difficulty with mutual interference between stations — thus trading one problem for another!

It is not surprising, therefore, that there has long been speculation about alternatives to the AM system in general, and to medium-wave AM broadcasting in particular.

Beyond this, community pressure has gradually built up, not just for noise-free radio reception, but for a greater variety of radio programming.

As long ago as 1925, Major Edwin Armstrong sought to advance the claims of FM (frequency modulation) on the basis that an FM receiver would be far less sensitive to atmospheric and electrical interference than its AM counterpart. The proposition didn't get very far, partly because of limited receiver technology and partly because it was feared that practical FM modulated carriers would take up a prohibitive amount of space in the radio spectrum then considered useable.

In any case, such a change in method would have been embarrassing at the time, both tecnically and commercially. Armstrong's ideas were heard without enthusiasm and without much practical response.

There the matter largely rested for about 10 years until advancing technology and pressure on spectrum space caused engineers and authorities alike, in the USA in particular, to take a more careful look at the possibility of establishing broadcasting and other services in the VHF spectrum.

There was space in that part of the spectrum to accommodate a large number of additional stations but, more than that, VHF offered two potential bonuses:

SERVICE AREA: VHF signals tend to blanket an area to just beyond the horizon from the antenna and, only in rare circumstances do they reach more remote areas. Thus transmitters could be sited to serve about an 80kM radius, with little chance of the signal being heard much beyond that. Stations all across the nation could share a limited number of frequencies, without mutual interference, provided they were sited sufficiently far apart.

NOISE INTERFERENCE: At VHF, atmospheric interference is much less of a problem than at lower frequencies, and even man-made interference is less of a worry at and above 100MHz. VHF technology therefore seemed to offer accommodation for more stations of all kinds, freedom from mutual interference, and a substantial reduction in noise interference from all sources.

When an audio waveform (top) is amplitude modulated on to a carrier, the result is as depicted at centre. With frequency modulation (bottom) carrier amplitude remains constant but the frequency varies.

Realising that the changing situation might present a new opening for the FM system, Major Armstrong set up an FM demonstration system in his laboratory in 1933. In the following year, the equipment was moved to the Empire State building and a low power (2kW) VHF FM transmitter set up to operate in parallel with a standard 50kW AM transmitter operated by the NBC.

During the following 12 months, the 2kW FM transmitter showed its ability to outperform the 50kW AM transmitter during periods of heavy static within a radius of 70 miles. Against this, the FM signal did exhibit poor spots in its coverage pattern, and Armstrong seemingly could not convince the NBC that it should increase the power of the FM transmitter or take other steps to investigate the problem.

In fact, Armstrong found himself up against three apparent and unfavourable attitudes:

1. Established networks were not keen to encourage any kind of splinter activity in sound broadcasting.

2. The same networks were far more interested in the potential of television and it seemed logical to them that resources and the first call on frequencies should be aimed in that direction.

3. Engineers tended to regard Armstrong as an over zealous enthusiast and, as a result, they under-estimated the potential of his system.

However, he kept hammering away at the Federal Communications Commission and the engineering fraternity. A paper published in 1936 is now one of the classic papers on the subject: "A Method of Reducing Disturbances in Radio Frequency Signalling by a System of Frequency Modulation"

Armstrong stressed in the paper that an FM receiver could readily be designed to reject variations in signal amplitude and therefore a very large proportion of otherwise objectionable noise interference.

He showed convincingly that the natural advantages of VHF broadcasting could be supplemented by the use of frequency modulation, with its inherent ability to discriminate against all kinds of unwanted noise.

Despite this, arguments about the merits of VHF broadcasting, of the FM system, about television and frequency allocations, persisted until they were interrupted by World War II. But, as it happened, the pressures of war greatly accelerated research, and engineers emerged from the period knowing a great deal more about VHF technology and FM as a method of communication.

Also, in the immediate post-war period, there was a strong focus of interest in high fidelity sound reproduction — an interest which produced first the long playing record, then the tape recorder.

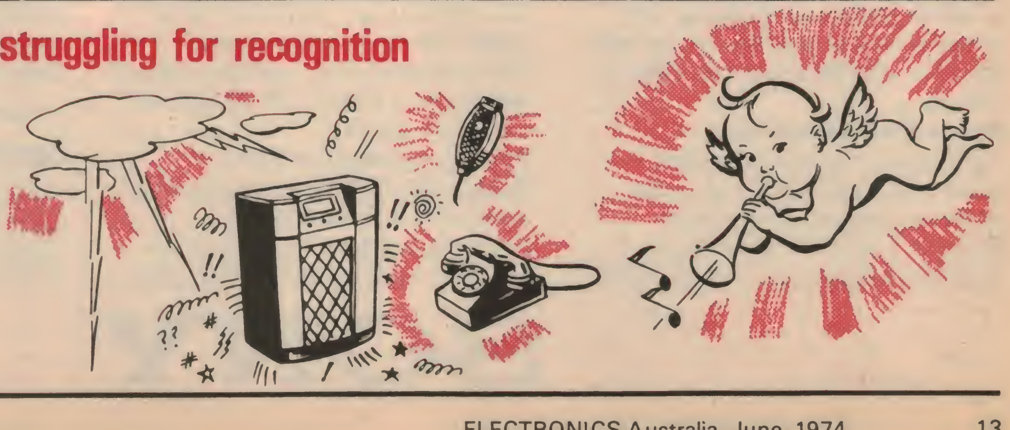
In the area of broadcasting, enthusiasts were becoming acutely aware that they were losing a large proportion of the high audio frequencies because of the necessary sharply tuned circuits in typical AM broadcast receivers. While AM receivers operating in a VHF band need not necessarily suffer the same limitation, there was a suspicion that they might! Listeners already knew from earlier and rather limited experience, that an FM system could provide the full audio bandwidth, almost as a matter of course.

The tide was therefore running strongly in the USA in favour of a full-scale VHF FM broadcasting system. In their post-war planning, the FCC reallocated the 40-50MHz region used for FM in its experimental and developmental stages, and set up a new FM band between 88-108MHz. At the same time, standards were laid down for transmitters and receivers, and modern FM broadcasting was on its way.

While interest in FM and VHF broad-

When FM radio was struggling for recognition

The General Electric Company commenced marketing FM receivers in 1938, to receive GE and other stations within the band 42 to 50MHz. Sales literature had to educate the public as to what FM was all about, the emphasis being on low background noise and "pure, sweet music."



FREQUENCY MODULATION

casting was by no means confined to the United States, the decision set a firm pattern for the Americas and for Japan which, of course, ultimately became a VHF / FM stronghold.

In Europe, there was a similar pressure on space in the medium-wave broadcast band, and similar speculation about transferring some of the activity to VHF. Early on, Britain tended to favour the AM system, while, in Germany, there was a strong bias towards FM, even before the outbreak of hostilities. Dr Lothar Rodhe, one of the key witnesses in the recent Australian inquiry into FM, is credited with having built the first European FM transmitter, and with having made notable contributions to FM technology.

In fact, along with band usage and frequency allocations, the question of AM v FM became the subject of quite heated debate in the European zone.

Facing the need for a firm decision, the BBC conducted a series of tests which finally led to the adoption of the FM system for Britain's supplementary broadcasting service.

Apart from factors mentioned earlier, British engineers were swayed in their judgment by two further important considerations:

When the signal from another FM station does appear in a receiver along with the wanted signal, the unwanted one is not heard provided its amplitude is always less than half that of the main signal. This so-called "capture effect" by a stronger signal provides an enormous advantage and allows stations to be sited much more closely than otherwise would be the case.

In an AM system, the same degree of immunity would demand a ratio between the wanted and unwanted signals of about 25:1.

The other interesting point was that of transmitter design economy. To provide a given power output from an FM transmitter, the final power stage need only be rated to handle that power, plus a reasonable margin. In an AM transmitter, the carrier will achieve twice the amplitude and four times the power on modulation peaks, so that a much more generous — and expensive — output stage is required.

While reference has been made only to decisions in USA and Britain, there was a more or less parallel trend in Europe, Japan and elsewhere, and out of it emerged a fairly universal set of system standards, of which three can be mentioned appropriately — but very briefly — at this stage: band, modulation and audio response.

BAND: VHF FM broadcasting is normally located within the frequency range 88 to 108MHz. Not all countries use the full band, nor even the same segments, but most stay within these limits.

MODULATION: By similar agreement, an FM broadcast station is considered to be fully modulated when the maximum carrier frequency swing on amplitude peaks is to 75kHz either side of the assigned figure. Expressed another way, maximum planned "deviation" is plus and minus 75kHz, or 150kHz total.

AUDIO RESPONSE: A third convention for FM broadcasting is to boost the treble response at the transmitter and to attenuate it by a similar amount in the receiver. By so doing, any noise or hiss that does penetrate the reproducing chain will tend to be reduced, along with the excess treble response. The reasoning, in fact, is similar to disc record practice, where the treble response on playback is deliberately rolled off to produce, hopefully, a level response overall.

One small hitch is that the amount of de-emphasis is not standard around the world. The British broadcasting system has opted for somewhat less boost and cut than selected in America. Over and above that, it would appear that some tuner manufacturers vary the amount of treble cut rather arbitrarily to produce what they judge to be the best overall result. However, the difference is purely one of degree and tonal balance can usually be set to one's personal preference by a slight up or down nudge of the amplifier treble control.

With the emergence of stereo records, pressure developed to set up a system of stereo broadcasting and the FM system was the one which seemed most adaptable for the purpose. A great deal of research went on in the USA in particular, in the late 1950s, aimed at producing a system which would be mono / stereo compatible. Stations could thus transmit a stereo program which would be resolved as such by suitably designed tuners. However, the same program, heard on a conventional mono tuner, would simply be reproduced as an acceptable mono signal — as was already the case with stereo records.

Various proposals were submitted to the American FCC (Federal Communications Commission) and, after thorough field testing, the FCC promulgated a set of standards based largely on parallel proposals from Zenith Radio Company and General Electric.

While the FM stereo concept warrants a separate article, in a nutshell the standards provided that the sum of the two stereo channels would constitute the basic and normal modulation for the carrier. Received on a conventional tuner, the stereo signal would be therefore resolved as a mono program, as happens when a stereo record is played on a mono system.

However, a "difference signal" obtained by combining the stereo components out of phase, would be modulated on to a supersonic frequency, which is modulated in turn on to the main carrier. New stereo tuners would separate out this additional signal, and "matrix" (or combine) it with the main modulation to derive the original stereo pair; these signals are passed on to the amplifier system.

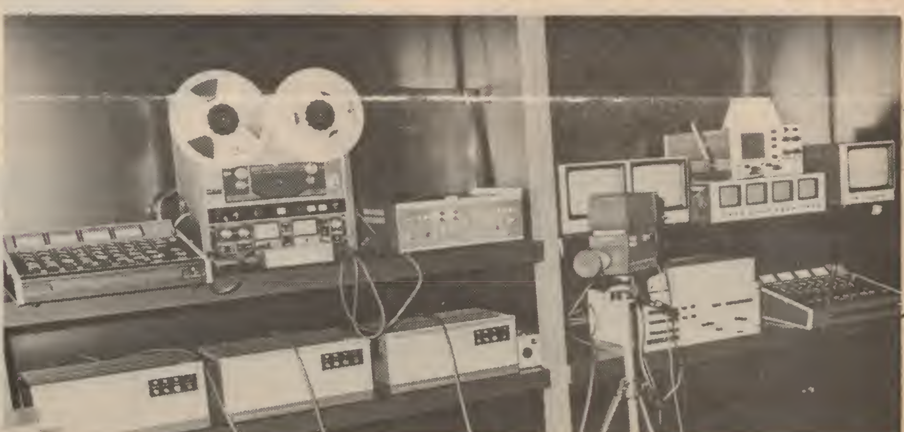
It sounds complicated but it can be made to work well. In fact, the matrixing of audio signals has become an everyday routine with the release of quadraphonic recordings, which blend four signals into two channels.

It became obvious at the time that the technique could readily be extended to impose two extra signals on the main frequency modulated carrier: the "difference" signal already mentioned and another quite unrelated mono program.

This "SCA" (Subsidiary Communication Authorisation) channel allowed FM stations to transmit a second service program, which might typically provide background music for local business houses; it offered a possible source of additional revenue to stations which were financially none too strong at the time.

SONY AT THE OPERA HOUSE

Pictured at right is Mr Yoshii, Senior Managing Director of the Sony Corporation, Japan. Mr Yoshii was speaking at the "Sony at the Opera House" exhibition, opened by the Lord Mayor of Sydney, Alderman Nick Shehadie. Displayed at the Exhibition was a very wide range of audio and video products, with a heavy emphasis on colour television. Below is shown one of many display areas; in the foreground is a small monochrome CCTV camera with electronic viewfinder.



FREQUENCY MODULATION

FM stereo broadcasts went to air officially within a few weeks of the FCC decision and the stereo facility was undoubtedly one of the factors which has since boosted the fortunes of FM stations.

Similar standards were adopted by other countries which had an FM broadcasting system so that, nowadays, FM broadcasting is rapidly becoming synonymous with stereo, at least at the transmitting end. A large proportion of the listeners still only have mono tuners but stereo tuners are featured in much of the new equipment currently on sale.

Curiously, one of the problems which has slowed the universal adoption of stereo broadcasting has nothing to do either with transmitters or receivers. It is the problem of conveying stereo signals to network stations over conventional program landlines. While a mono signal can be conveyed over any program-quality landline, stereo signals required two landlines with closely matched phase and delay characteristics. Even in a country as compact as Britain, stereo broadcasting has had to spread at a rate dictated by the provision of program links of a different kind.

As far as Australia is concerned, there was an early tacit assumption that a system of FM broadcasting would be initiated in due course and, in 1946, the band 90-108MHz was set aside tentatively with a view to accommodating ultimately 90 FM channels. It was suggested that experimental transmitters could be set up in each capital city by the ABC and by the Federation of Commercial Broadcasters to evaluate the FM system in the Australian environment.

In 1947, transmitters operated by the PMG were set up in Sydney, Melbourne, Brisbane and Adelaide and fed with program material patched in from the ABC network. The Federation of Commercial Broadcasters took no action and, in the following year, the Broadcasting Act was amended to prohibit the use of FM by any commercial station.

1949 saw the establishment of the ABCB (Australian Broadcasting Control Board) and its early attitude was to favour strongly the introduction of FM broadcasting. Amongst other things, it secured repeal of the prohibition against commercial FM stations.

Meanwhile the "experimental" transmissions continued but they were never publicised or scheduled — presumably to discourage the public from assuming that they were official or that it was appropriate to invest in tuners or receivers.

However, as the time approached for the opening of the television system, interest in the FM proposals was totally overshadowed and, in its 1958 report, the Board recommended that consideration of an FM service be set aside for the time being.

In fact, such was the public response to television, that the government of the day felt justified in re-planning the system to provide more channels and more stations. In the process, that part of the VHF spectrum which would otherwise have been reserved for FM broadcasting, was reallocated to television and other services. The experimental services were closed down — this in June 1961.

There were protests from those who were looking forward to a full FM service, but they were set aside. The electronics industry had a far bigger stake in television and "other services", while the broadcasting interests were just as happy to see a possible competitive system pushed aside. The public didn't care, because the public didn't know, and they were preoccupied by television anyway!

Some did notice the high quality of pre-transmission music received on their TV set — carried to them by an FM system — but the observation did not count for much.

In many respects, the situation was strongly reminiscent of that in the USA around 1940, when Armstrong was fighting a seemingly losing battle against television, the networks and industry forces.

The Australian administration conceded that a supplementary broadcasting service would be necessary in Australia, in due course, probably after the transition to colour television. It would operate on a UHF band, probably around 450MHz, but it could be planned to take full advantage of the then "state of the art".

To many, this had all the elements of a "pipe dream", which they would be too old to enjoy!

There the matter rested until the change in Government in late 1972. Initially, the new Government indicated that it would go along with the earlier planning but the decision was by no means unanimous. Because of this, and renewed agitation for an FM service on VHF, the Government set up an independent inquiry, in 1974, conducted by Sir Francis McLean, former director of engineering for the BBC, and economist Professor C. C. Renwick.

The Inquiry strongly recommended initiating an FM service within the internationally recognised limits of 88-108MHz. Some stations could be put into service with a minimum of delay, with location, frequency and power, selected so as to slot between TV channels, without causing interference in existing TV receivers. Television stations operating within the FM band would gradually be reallocated to other channels and the band progressively cleared, over a number of years, for the operation of a full-scale FM stereo service.

The Government accepted in principle the recommendations of the Inquiry and the plan now only remains to be implemented.

While it may be relatively easy to provide an interim mono service by reviving old equipment and taking split from the ABC program lines, detailed multi-station planning and provision of separate stereo programming will obviously take longer — how much longer will doubtless depend on the political and economic climate.

The important point, however, is that the revised plan will ultimately bring Australia more into line with overseas practice and provide meaningful signals for the many FM tuners which have found their way into Australia as an integral part of imported equipment.

And New Zealand? There has been consistent minority pressure in that country also for a VHF FM service — and a no less consistent rejection of the idea by successive governments. It may well be, however, that the abrupt about-face in Australia will strengthen the case for an ultimate parallel decision across the Tasman.

(To be continued)

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Sansui equipment is distributed throughout Australia by the Bleakley Gray Corporation Pty. Limited, a Division of Rank Industries Australia Pty. Limited. Sales and service facilities are nation wide . . . and Sansui performance is matched only by the enthusiasm of the specialist hi-fi stores . . . *the men who sell Sansui.*

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We try to look at products through your eyes

On what basis do we assess the products — particularly the hifi products — which are reviewed each month in Electronics Australia? This question is put to us from time to time, by readers and by distributors. The heading gives a clue to the answer: we try to evaluate products from the viewpoint of the likely consumer, combining subjective reaction with laboratory testing.

Just to set the record straight, Electronics Australia does not seek to run direct, comparative A-B-C-D tests between competitive products. That role and that task belongs to consumer organisations and consumer magazines which have their financial and legal basis in registered subscriptions. They exist for that purpose and, in many cases, for that purpose alone.

As in most other bookstall magazines, products are reviewed in "Electronics Australia" on an individual and spontaneous basis. In many cases we review them at the request of distributors; in other cases, the initiative comes from us.

When a product is made available for review in this way, we are free to test it and to make fair comment — and this we do without pressure from the manufacturer or the distributor. In fact, if there was hint of such pressure, we would opt out very smartly. Our whole credibility as a technical magazine would suffer if it became evident that our reviews were being "cooked" to please advertisers.

By implication, distributors must have confidence in a new product — and in our impartiality — to expose them in this way.

To be realistic, they do not expect — and we do not expect — to find "perfect" products: units which are above criticism and which outperform and undersell everything else on the market! A more practical aspiration is to expose a product which is thoroughly competitive in performance and price and which will attract its share of buyers.

Occasionally — just occasionally — we have to thoroughly "pan" something but, curiously, this has not made us bad friends with anybody — at least locally. As often as not, a bad report is used by a distributor as "ammunition" to have a product improved or up-dated.

Superficially, it might seem that the whole function of a review is to evaluate a particular product as a guide to intending buyers and, undoubtedly, it will serve this purpose.

But, if that were the sole reason to publish reviews, they might figure a lot less in hifi magazines. They would represent so many wasted pages to the army of enthusiasts who, at any one time, are NOT immediately interested in buying a new amplifier, a new cassette player, or some new exotic piece of hifi gadgetry.

In fact, over and above the evaluation of specific products, reviews tend to crystallise trends and design achievements, giving substance to that overworked phrase: "the state of the art". As a result, they tend to be read with interest, whether or not the reader has any immediate intention of buying a similar product.

And this remains true, even though we are able to examine only a limited cross-section of the products on the market.

Take cassette players for example:

There are literally dozens of models available, of varying shape, size, specification and price. If you have any idea of buying one at some time in the future, you'll probably read published reviews with interest. You'll gradually build up a picture of the facilities that are provided, reviewer's reactions to them, the features that would seemingly be relevant to your needs, what to look out for, what to be wary of.

You may finish up buying a model that has not, to your knowledge, been reviewed — yet your choice has been educated by comments on a variety of other machines.

It is because of these factors that we try to adopt a consumer orientated approach to reviews in "Electronics Australia", not only with hifi equipment but with records and tapes as well. We try to see products through the eyes of the class of consumer at whom they are aimed. Will the likely purchaser be happy with the item which he or she buys?

by NEVILLE WILLIAMS

This means, in practice, that our reviewers have to adopt postures appropriate to the product, rather than making learned pronouncements from some heavily instrumented ivory tower. Those who follow our record and tape reviews will surely have been able to sense this. If the appeal of a recording is one of nostalgia, or long-play mood music, we don't ridicule it because it lacks the sparkle of the latest hifi technology. The intention is defined and the recording evaluated on that basis.

Similarly, if a piece of hifi equipment is intended for the budget conscious consumer, we test and review it with that in mind. If it represents good value for money and we feel that the likely consumer will be pleased with it, we say so — even if it falls well short of the ultimate.

Equally, if we are asked to review the "ultimate", with price tag to match, it is reasonable to apply ultimate criteria.

But enough of the generalities. How do we go about testing and evaluating typical pieces of equipment? And are they truly random samples or have they been "prettied up" before we see them?

Sometimes they are random samples, taken unopened from a shipment. Sometimes they are one of a couple of advance units airfreighted to the distributor for evaluation and publicity. Far from being "prettied up" these may well have been trundled around Australia to interstate branches!

Rather than follow hard and fast rules, we try to apply ordinary common sense. Is the item basically well designed, and well constructed? Does it align with modern practice and market needs? Is it capable of meeting specs? Does it represent reasonable value for money? Are there faults and omissions which warrant special mention? If there are faults, are they likely to be isolated or symptomatic, and would they be covered by guarantee?

And so on . . .

When a piece of equipment comes in for review, we normally unpack it, check inclusions, remove transit bolts, &c, and set it aside on the bench awaiting a trip to the photographic studio.

During this phase, it is sitting in our laboratory, exposed to the attention and the curiosity of the dozen or more people who may be in there during the course of a couple of days. And, as you might imagine, those people react quite spontaneously to it. It's big, bulky, small, compact, nice, nasty, neat, gaudy, &c.

But often the remarks are perceptive to a significant degree, as comparison is made with what the observers own, or have noticed in shops and advertisements.

Then comes the actual testing and instrumentation.

With the aid of test recordings we measure the performance of phono cartridges, noting frequency response, distortion, tracking, channel separation, output level. Then we listen to their performance on typical — and familiar — recordings, in case some quality should emerge which did not show up on the meters or CRO face.

With tape machines, the routine is rather similar, except that we have to measure recording characteristics as well, overall record/play response and distortion, and signal/noise ratio.

Amplifiers are relatively easy to test because they lend themselves so completely to instrumentation. We use a low distortion wide-range audio generator, resistive loads, a Hewlett-Packard noise and distortion meter, Advance or Telequipment oscilloscope, and one of a number of digital voltmeters.

(Continued on page 25)

Sound delivered at the speed of light.

We will deliver any sound system — not quite at 186,000 miles per second* — but within 24 hours to anywhere on the East Coast of Australia. And within 48 hours to anywhere on the West Coast.

All you have to do is fill in the coupon below and send us a bank cheque for the correct amount. Within 24 hours of receiving your order (or 48 hours if you live on the West Coast), we guarantee to have the sound system of your choice on your doorstep.

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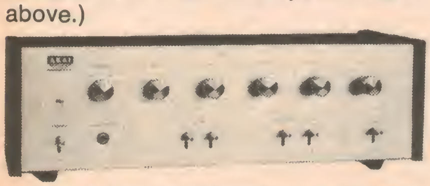

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I enclose my bank cheque for $..

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APAN BFU-121 auto turntable

An automatic turntable is certainly a boon in any stereo system, but high-quality units can be very expensive. One machine which certainly should be considered when buying is the Apan BFU-121. This is a fully automatic single-play turntable which is belt-driven and is supplied with magnetic cartridge.

The Apan BFU-121 is top model in a range of three turntables distributed in Australia by Ralmar Agencies Pty Ltd. It is normally supplied complete with walnut-veneered base and smoke-tinted perspex cover.

Outside dimensions of the base and cover are 434 x 346 x 180mm (W x H x D) while the perspex cover requires 80mm clearance at the rear of the unit to allow it to open fully. If you buy the unit without base and cover and mount it yourself, full mounting instructions are supplied on a full size diagram which is available upon request. Dimensions of the player deck are 390 x 305mm and the arm counterweight does not normally overhang at the rear.

When you purchase one of these turntables, the player is carefully assembled in one carton while the base and cover is packed in another carton. It all goes together quite simply and without problems, following the brief but concise instructions. We found no problems at all in setting it up and all who saw it agreed that it was very well finished.

The platter is a 30cm aluminium diecasting weighing 1.3kg. It is belt-driven from the resiliently mounted 4-pole synchronous motor via a 5mm wide polished neoprene belt. Speed change is provided at the motor spindle for 33 or 45 rpm. We found the turntable bearing very quiet and free. As evidence of this, we took the belt off, spun it up to 33 rpm and then let it run down. It took just over 90 seconds to come to a halt.

Appearance of the tone arm is very similar to that on many Japanese turntables. It has a rotating counterweight which balances the arm as well as providing the means of vertical tracking force. Anti-skating force is applied by a small weight and lever system on the arm hub. The headshell is removeable and has the EIA standard locking collar, standard colour-coded cartridge leads and provision for stylus overhang adjustment. The headshell takes all cartridges with 12.5mm mounting centres.

Damped arm lifting and lowering is provided by a small lever on the control panel. The damped lifting and lowering function also comes into operation during automatic play. Two control levers and a push-button are provided for automatic play. One selects the record size while the other, together with the concentric push-button, provides the functions such as Auto start, stop, manual and repeat.

Pushing the main control lever to Auto starts the motor running, moves the arm over to the start of the record and lowers it gently. At the end, the arm lifts and returns to rest and switches off the motor. Pushing the control lever to Repeat after playing has begun enables a record to be repeated continuously. And leaving the player in the Manual mode, you can start the motor simply by moving the arm away from the rest. At the end of play, it returns to the rest in the normal way.

At all times, the BFU-121 functions quietly and appears foolproof. The main drive cam gear is made of nylon instead of the more usual zinc diecasting found in record changers, so that it should stay quiet. All the levers in the sample mechanism were well-lubricated, too, which is not always the case. Some automatic turntables we have seen in the past do not appear to have been greased at all.

We found that the automatic stop mechanism would function reliably with cartridge tracking forces down to ½ gram, which is adequate. However, we would not recommend the turntable for use with high compliance cartridges intended to track at 1 gram or lower, because of bearing friction in the arm. The people at Ralmar Agencies Pty Ltd agree entirely with this recommendation but point out that they supply a cartridge with the unit which will satisfy all but the most discriminating users. Discriminating users, we might add, will require a correspondingly fatter wallet.

No muting is provided on the turntable, ie, the cartridge leads are not shorted out during the automatic cycle. However, the arm movements are quite gentle and since "clunks and bongs" were not at all evident from the loudspeakers while the mechanism was functioning, muting does not seem to be important. A capacitor is connected across the motor switch to prevent switching transients being radiated from the mains wiring into the signal wiring.

We found the fixed anti-skating force applied on the arm insufficient for the tracking weight normally used with the supplied cartridge. However, this is really not a problem, as the measurements indicate. Normally, tracking weight is set at 2.5 grams.

Cartridge specifications are quite modest, which is surprising in these days of pretentious specs. A 0.6mil conical diamond stylus is fitted. Cross-talk at 1kHz is rated at 15dB or more while at 10kHz it is rated at 8dB or more. Channel balance at 1kHz is within 2dB. Frequency response and compliance or tracking ability was not quoted.

Using the CBS STR 100 test record we measured frequency response of the cartridge at plus or minus 3dB from 20Hz to 20kHz. Crosstalk at 1kHz was minus 30dB in both directions while it was more than 10dB in both directions at 10kHz. Channel balance was within 3dB over the whole range. Waveform of the cartridge was good, about average for a typical magnetic cartridge.

Tracking performance was checked on the W&G 25 / 2434 test record. At 2 grams it tracked the plus 12dB test track while at 2.5 grams it almost but not quite tracked the plus 16dB band without distortion. For most records, it will track quite well at about 1.5 grams. In general, the performance of the cartridge is quite good and is typical of several medium-priced better-known brands.

Rumble of the turntable proved very difficult to measure because we are plagued with inherent building rumble. However, we were able to determine that rumble was very low and well below the majority of idler driven turntables.

The only negative comment we want to make concerns the small moulded 2-pin mains plug. These are fitted to an increasing proportion of high fidelity equipment imported from overseas. As such, these plugs are intended for 110V operation and are quite dangerous at 240V. The reviewer found this to his cost. I received a severe shock because my fingers accidentally came in contact with the plug pins when pulling the plug out of a socket on the back of an amplifier. The plug moulding is so small that this easily occurs.

Admittedly, one should disconnect amplifiers from the power point before plugging in other equipment, but this is all too easy to forget when you are in a hurry. Australian plugs and sockets are designed so that it is almost impossible to come into contact with the mains when inserting or removing a plug from a socket. So, a general warning, if the equipment you

(Continued on page 25)

SAE Stereo Equaliser and Power Amplifier

Scientific Audio Electronics, Incorporated are represented in Australia by Leroya Industries Pty Ltd. Here we review the SAE Mk 1B stereo preamplifier which has a "graphic equaliser" and the SAE Mk IVCM stereo power amplifier.

It is not often that we have the opportunity to review really expensive equipment, since readers and equipment distributors alike are mainly interested in the "middle price range" of the market. But it is interesting to look at the gear offered to the man who has more than a few dollars in his pocket.

The SAE equipment to hand was a Mark 1B Stereo Preamplifier Equaliser plus the Mark IVCM Solid State Stereo Power Amplifier. Together, they form a superlative stereo amplifier system with many unusual features. Let's look at the Preamplifier Equaliser first. It really could be called a solid state control unit.

Most unusual feature of the unit is the group of seven slider controls which replace the usual bass and treble tone controls. This group of controls is called a "graphic equaliser".

Graphic equalisers were first used in recording studios to compensate for deficiencies in equipment and acoustics. The equaliser splits the audio spectrum into a number of frequency bands and has a control to boost or attenuate each band so that sharp peaks or dips con be corrected.

Ideally, the narrower the frequency bands the better, as this enables very sharp peaks such as occur with loudspeakers to be correctly compensated. Some graphic equalisers have as many as three controls per octave; others have the controls at octave spacing. This SAE unit, designed primarily for home use, has the controls at more than octave spacing with the bands centred on 40, 120, 320, 960, 2.5k, 7.5k and 15kHz.

Total boost and cut available on each frequency band is plus or minus 16dB, which is rather more than is available on normal tone controls. There are three push-buttons associated with the equaliser controls: one defeats the control settings to provide a flat frequency response; one reduces the range of control to plus or minus 8dB and the third enables tape recordings made via the unit to be tonally compensated.

We will talk more about the equaliser controls later in the review.

Another interesting feature of the Mk1B is the volume control. Instead of the normal rotary ganged potentiometer, it is a 23-step rotary switch with a total range of 33dB. SAE use the rotary switch to obtain very close tracking between channels, which is just not possible with a carbon track ganged potentiometer.

Immediately below the main volume control is a five position gain switch which changes the gain in 12dB steps. Besides enabling you to set the gain of the system to suit room and loudspeakers it also acts as a handy muting switch, for use during telephone conversations and similar situations, where you do not wish to change the volume control setting.

To the right of the gain controls are the balance control and the loudspeaker selector. How can a preamplifier-control unit switch the loudspeakers? A heavy cable carries the output signal from the power amplifier back to the preamplifier whence it is switched and routed to a set of output sockets on the rear of the unit.

Comprehensive input facilities are provided via the Selector and Mode switches, so that tape monitoring and copying can be done between three recorders, one connected via the front panel sockets and the others connected via the rear panel.

On the rear panel of the Mk 1B is the unusual array of RCA sockets, speaker sockets and 2-pin mains sockets. Also on the back is a push-button which increases the gain of the entire system by 20dB if need be. This is a good feature, as it provides extra gain which is not likely to be switched in by accident, possibly damaging loudspeakers by overload.

Inside, the unit is very neatly laid out on three printed boards. One board, mounted vertically carries all the toroid-wound inductors for the equaliser controls. The other two boards are mounted horizontally, upside down from the top panel.

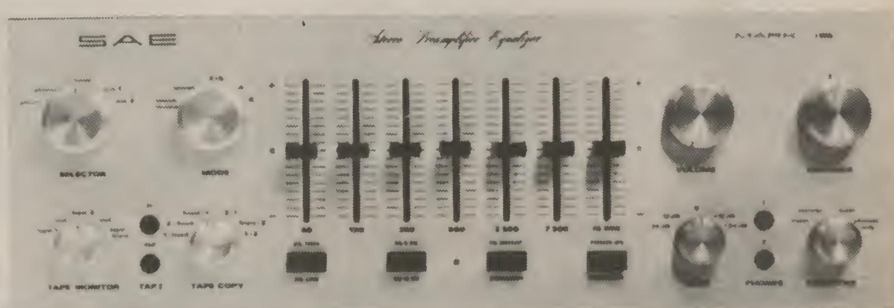
It was here that we came across the first problem with the equipment. It had arrived direct from the USA and the local distributors had not had time to inspect before submitting it to us. In transit, the power supply board, which carries the reasonably heavy transformer, had broken away from one of its mountings and was hanging rather precariously from the three remaining pillars.

We were inclined to believe that the weight of the transformer combined with the method of staking the mounting pillars to the board was responsible for the breakage. But Leroya state that apparently the plane flight to Sydney was extremely rough because several other items in transit had also been damaged. In any case, Leroya assure us that their normal inspection procedure would pick up this fault before it was delivered to the customer.

Both the units submitted for review were supplied without cabinets but Leroya Industries Pty Ltd state that all future deliveries will have imported timber cabinets supplied at no extra cost. The preamplifier and amplifier were supplied with two-core mains flex, which we frown on, but future deliveries will have a three-core mains cord and plug fitted.

Turning now to the Mark IVCM power amplifier, this has the same size front panel as the Mk 1B. On the panel, two large meters are mounted, together with two slider controls for Balance and Level control. Four push-buttons provide sensitivity adjustment for the meters which indicate the power output from each channel.

Inside, two very large power transformers provide separate power supplies for each channel. The supplies have balanced positive and negative rails to eliminate the output coupling capacitor. Instead of the usual finned heatsink, two large U-shaped 10-gauge aluminium heatsinks carry six power transistors per



channel. The power transistors are covered by a protective grille, which is necessary, since they operate at quite hefty voltages.

We were not able to refer to a circuit of the amplifier but it appears to be a quasi-complementary configuration with parallel connected output transistors. The voltage amplifier stages of the power amplifiers are mounted on two large printed boards. These boards are mounted horizontally and secured at one end; they are supported at the other end by the wires to the large filter capacitors, which gave the boards a twist. Not a very good method. We understand that the local distributors are making approaches to the manufacturer to have this aspect improved.

Another problem we found was the illumination of the power meters. These are mounted behind translucent black glass which present an inscrutable appearance (as shown in the photograph) when the amplifier was not in use. We found the meter illumination too dim even for very subdued room lighting conditions and feel that it should be increased. Why have the power meters if they cannot be read easily?

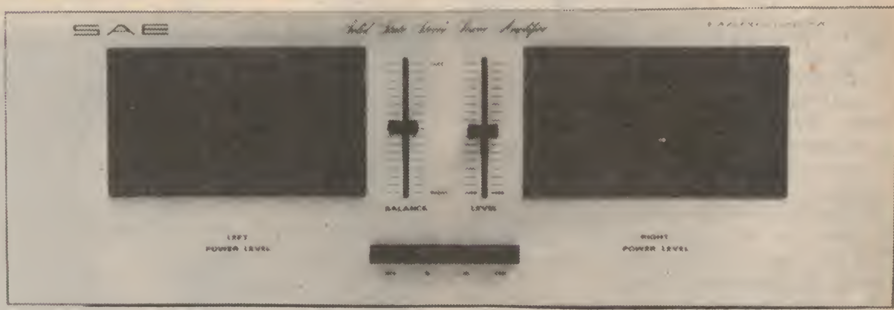
Naturally, we hooked both units together with a good quality magnetic cartridge and loudspeakers and had a prolonged listening session. At first, we were a little sceptical about the use of the "graphic equaliser" controls but after a period of use we think it has worthwhile application in a high fidelity system of this class. The catch is that you must have a discerning pair of ears or a calibrated microphone, or both!

One does not use graphic equaliser tone controls to "boost the violins" or "give a lift to the bassoon" as some manufacturers would like the consumer to think. Rather, the equaliser is used to compenaste characteristics of the system , such as mid-frequency prominence, a tendency to "honkiness" in the loudspeakers, lack of extreme treble due to cartridge roll-off and so on. Such corrections tend to be subtle rather than the massive changes effected by normal tone controls.

So if one uses the equaliser controls sensibly they can effect very worthwhile changes to the system. But we are inclined to the view that this sort of facility should not be exposed on the front panel — it is all too easy to "play" with the controls which defeats the purpose of providing them.

Getting down to facts and figures, the rms that the distortion rose to 0.15 pc. This was with the equaliser controls set for a flat response. With typical boost and cut settings and the output signal set for 1V, the worst distortion measurement was 0.24 pc.

Signal-to-noise ratios claimed were a little difficult to verify since they did not specify how the inputs were to be loaded and whether the figures were weighted or not. Either way, the figures were very good anyway. With the phono inputs shorted, the signal to noise ratio was close to 80dB with respect to 10mV input which was the figure



Mark IVCM is rated at 250 watts total continuous power into 8-ohm loads, or more than 100 watts per channel. This was easily checked. We measured power at 128 watts per channel, whether driven separately or together. Distortion is rated at less than 0.1 pc but at all times it was below the threshold of our instrument capability of about 0.03 pc. Other specifications such as frequency response, power bandwidth, damping factor and stability were all easily met.

Sensitivity of the power amplifier is 1 volt for full power. At this output from the Mark 1B we found it again impossible to measure harmonic distortion. It was not until we raised the output signal to a whopping 13V quoted. At any rate, the two units operating together are very quiet.

Summing up, the SAE Mk1B preamplifier equaliser and Mk IVCM power amplifier are a very high performance team which should give years of satisfaction. They are expensive, but they have many worthwhile features not found on other equipment. Recommended retail prices are $799 for the Mk 1B and $663 for the Mk IVCM.

SAE equipment is available from selected retailers throughout Australia. For further information, contact the Australian distributors, Leroya Industries Pty Ltd, 266 Hay Street, Subiaco, WA, or interstate branches. (L.D.S.)

Apan from p21

purchase has 2-pin plugs intended for 110V operation, remove them and fit approved Australian 240V plugs.

Apart from the above complaint, which is easily rectified, we were impressed with the Apan BFU 121. It is one of the few fully automatic belt-driven turntables presently available. And its soaring sales testify that it's a bargain at a recommended retail price of $112 including arm and cartridge. The base and cover add $26.85 to provide a complete package of $138.85. Warranty is 12 months from date of purchase and a plentiful supply of spare parts is maintained by the distributor.

For further information on the Apan range of turntables, contact your nearest high-fidelity retailer. Trade enquiries should be directed to the Australian distributors for Apan, Ralmar Agencies Pty Ltd, 71-73 Chandos Street, St. Leonards, NSW 2065. (L.D.S)

PRODUCTS THROUGH YOUR EYES from p19

With this set up, it is possible to plot very accurately the frequency response, the effect of various controls and filters, power output, distortion at various power levels, signal / noise ratio for all channels, and so on. We can — and do — check transient behaviour with square-wave input, and stability into reactive loads.

This is the stuff of which photographs and impressive curves are made but, to conserve space, we normally summarise behaviour in words. It is possible to express quite succinctly that the normal response is flat between certain limits, that bass and treble boost and cut amount to so many decibels at certain frequencies, and that the amplifier does or does not meet specifications in various respects.

Loudspeakers pose a special problem in that one needs to own or hire an anechoic chamber with full instrumentation in order to measure response. And even then, as Professor Bose pointed out recently, you still have to listen to a loudspeaker system to see whether you like it — whether it sounds like it looks!

Because of this, we tend to rely heavily on A-B listening tests, comparing a single system with other known single systems, and using a range of familiar mono program material. Invariably, we try for a group verdict.

In special cases we get as close as we can to consumer conditions. For example, tests on the Philips Quadreflect system were organised in the writer's own home and we lived with them for a couple of weeks. Out of the experience came the firmly worded conviction that this kind of system made special demands upon room layout and decor.

But that wasn't by any means the ultimate in consumer orientated evaluation.

Remember the recent Heathkit metal locator? One of our staff members used it to trace pipes and wires around his home, preparatory to renovations, then handed it over to a couple of teenage sons to survey local surfing beaches. They unearthed large numbers of bottle tops and quite a few coins — and thoroughly enjoyed themselves in the process!

Yes, the metal locator worked well.

With the Heathkit depth finder we went one better again. We arranged for Greg Swain, who put the kit together, to install it on staff member Bob Flynn's boat. The two of them spent most of a calm sunny day looking for shoals and fish in Broken Bay. But, of course, they were under strict instructions: being a job of work, they were not to enjoy themselves!

So there you have it — our approach to evaluating products: a combination of group reaction, instrumentation and evaluation in a user situation.

News Highlights

Wrist "computer" shows decompression stops

Two scientists at the General Electric Research and Development Center in Schenectady, New York have invented a unique "wrist computer" that helps underwater divers to avoid the "bends" or decompression sickness. The new device automatically indicates to the diver the depths at which decompression stops must be made whilst surfacing, and makes obsolete the inaccurate meters currently used by divers and the need to memorise lengthy mathematical tables.

The, stop-and-pause procedure is standard practice for all deep water divers. It permits body tissues to get rid of the nitrogen absorbed when divers breathe high-pressure air. This action wards off the bends — the formation of nitrogen bubbles in the bloodstream that causes intense pain and often cripples the body.

The handmade prototype now shared by its inventors, Dr Borom and Dr Jonson, is about two inches high by two and three quarter inches in diameter. The GE inventors believe, however, that additional design will reduce the size of the production model by half, and they estimate a production model could be made to sell competitively for about $100.

Heart of the new GE "computer" is a wispy-thin silicone rubber membrane that allows air to pass through at controlled rates. The membrane material — developed by GE scientists about ten years ago — simulates the action of a diver's body tissues in absorbing and releasing nitrogen.

Diffusion models of body tissue behaviour during deep dives were first calculated some 20 years ago by US Navy underwater physiologists. The results have been printed in tabular form and are now widely used by scuba divers while planning underwater outings. However, the Navy tables are limited to specific depths and durations, with only 162 possible dives precisely scheduled.

"This is where our underwater computer really shines," say the inventors. "It calculates decompression schedules continuously over variations in both depth and time, and enables divers to stay down longer and spend less time in decompression," they explain.

Briefly, the system functions as follows. An air pocket inside of the "wrist computer" is separated from the surrounding water by a rubber bladder. Air pressure in the pocket is the same as the outside water. As water pressure increases, the air is forced against special silicone rubber membranes stretched across four different-sized air chambers, and diffuses through. Each chamber simulates the different absorption rates of various body tissues such as those found in muscle, fat or cartilage.

The "computer" automatically measures the air pressure inside each of the four chambers, and registers the highest pressure on its dial face. This action indicates the decompression schedule, and is controlled by tiny pressure-activated switches.

The dial face shows depths ranging from zero to 50 feet. As the diver ascends from a steep dive, the dial indicates the depth at which the first decompression stop should be made. For example, if the dial indicates that the first stop should be at the 40 foot level, the needle would remain at that mark until the gas in the controlling body tissue chamber decreases in pressure, thus informing the diver to rise to the next shallower depth. This procedure is repeated until the surface is reached.

—George E. Toles

RCA to develop laser tracking system

RCA Corporation recently announced that it is to design and build a new laser tracking system to provide NASA with more precise charting of its orbiting spacecraft. The system, which is being developed under a contract valued at nearly $US400,000 will be used specifically by NASA for more accurate tracking of the GEOS-C geodetic satellite.

Called the Laser Range Tracking System (LRTS), the device will be integrated with an AN/FPQ-6 radar system at NASA's Wallops Station in Virginia. In operation, the radar will acquire and track the target, provide range designation to the Laser Range Subsystem, and automatically aim the laser at the target. The laser then transmits pulsed light energy in a narrow beam at the spacecraft. Retroreflectors mounted on the spacecraft return the laser signal to the LRTS, where it is received through the collection optics and fed to a signal processor and range subsystem to determine the exact range of the satellite.

Motorola sells Stateside

Against a background of a softening US market for television receivers and a 1973 operating loss in their consumer products division, Motorola Inc have decided to sell the whole of their Stateside TV manufacturing and marketing operation to Japan's Matsushita Electric.

Under a deal, which has yet to be approved by the boards of the two companies, Matsushita will take over Motorola's manufacturing facilities in Franklin Park, Pontiac, and Quincy, Illinois, and Toronto, Ontario. Motorola are expected to retain their Taiwan TV plant, but convert it for the manufacture of other products.

Matsushita will continue to use Motorola's Quasar brand name, and will carry on marketing its own Panasonic TV sets in the US. The two brands should give the Japanese company third place in the US market, after Zenith and RCA, with a market share of around 9pc.

The deal must be reckoned a considerable coup for Matsushita. Ever since the dollar revaluation, Japanese setmakers have been wrestling with increasingly difficult conditions in the US — their major export market for television receivers. As a result, several of the Japanese TV giants have set up manufacturing or assembly plants in Mexico, Canada, or in the US itself. Matsushita, at one stroke, will acquire manufacturing facilities and an established distributor and dealer network as a going concern.

Rocket launches probe weather patterns

A record series of 79 rocket launches from 8 sites in the western hemisphere have been completed as part of a program to determine daily variations in temperature and wind conditions in the upper atmosphere at the time of the spring equinox.

The launches, made at regular intervals over a twenty-four hour period beginning at 12:05pm Eastern Daylight Time on March 19, were made from locations in North, Central and South America, the Caribbean Sea, and the Atlantic Ocean.

Single-stage Loki and Super Loki rockets carried meteorological instruments to heights of about 70 kilometres (40 miles). The payloads were then ejected and returned to earth on parachutes. As the instruments descended, atmospheric temperature readings were telemetered to ground receiving stations. At the same time, radar tracked the parachutes to reveal wind conditions in the upper atmosphere.

Four of the launch sites — Mar Chiquita, Argentina; Natal, Brazil; Kourou, French Guiana; and Wallops Island, Virginia — are part of the Experimental Inter-American Meteorological Rocket Network.

The other four sites — Ascension Island; Fort Sherman, Canal Zone; Antigua, British West Indies; and Fort Churchill, Canada — are in the US Cooperative Meteorological Rocket Network.

The series of launches is expected to bring scientists a better understanding of upper atmospheric circulation and temperature patterns.

Swift changeover to colour predicted

Mr Ken Stone, General Manger of Sydney's ATN Channel 7, recently predicted a rapid acceptance of colour TV by the general viewing public when the service begins on March 1 next year. He believes that this country, because of its high standard of living, is one of the most favourably situated in the world for the inauguration of a colour television service.

"There is a large amount of colour TV programming available, which viewers will be able to see 'au naturel' from C-Day 1," he said. "And stations will be transmitting substantially in colour from that date." In an observation on local news filing, he argued: "If we are going to send a news cameraman 15 miles or so to cover news with an expensive camera, there is no sense in not loading that camera with colour film."

Television stations right across Australia will be switching dramatically to colour on March 1, 1975. "As far as I can see," Mr Stone noted, "no television station is prepared to be left behind in the colour race, even the smallest. When you look at the program schedules of any TV station you can see immediately the vast amount of colour programming that is going to be telecast." He predicts that the demand for colour TV receivers will be such that they will be in short supply for a long time. "With our favourable wage and economic structure, and with colour starting nationally throughout 48 stations at the same time, there is bound to be an unfulfilled clamour for sets in Australia," Mr Stone forecasts.

Balloon borne X-ray telescope

After two and a half years of research and development, a team of British scientists are to continue their investigations of "black holes" in space by examining them through an X-ray telescope borne aloft by a balloon.

Black holes are regions where the gravitational effect of systems that have collapsed in on themselves is strong enough to prevent light escaping. These areas of extreme gravitational attraction are often the source of X-ray emissions, resulting in the birth of a comparatively new science known as X-ray astronomy.

The one and a half ton telescope will be launched from the Center for Atmospheric Research at Palestine, Texas, later this year for a six-hour observation of the star Cygnus, believed to be a typical black hole in space, and many hundreds of light years away. The balloon, which is some 107 metres in diameter, is designed to rise to a height of approximately 25 miles. At the end of the six hours of radio controlled observation, the telescope will be returned to earth via parachute.

Superconductivity temperature high

For some years, scientists have been experimenting with materials to see if superconducting temperatures can be raised to the point where it becomes economically practical to develop superconducting power distribution and electronic systems. Superconducting temperatures have been pushed upward degree by degree in the past few years as scientists investigated new materials, and a new record high of 23.2 degrees K (-418 degrees F) has recently been recorded at Bell Laboratories.

Previous to this, John Gavaler of Westinghouse Research Laboratories succeeded in raising the critical temperature for superconductivity in niobium-germanium alloys to 22.3 degrees K (—419.56 degrees F). This broke the previous record of 20.98 K set earlier by Bell Labs. Gavaler's report led to the new work by L. R. Testardi, J. H. Wernick and W. A. Royer which set the current record.

Both Gavaler and the Bell Laboratories scientists achieved their results in thin films of an alloy of niobium and germanium, just a thousand atoms thick. To make the material into a thin film the scientists blasted a piece of niobium-germanium alloy with argon gas, dislodging some of the elements which then recombined as a thin film on a heated sapphire strip.

In earlier work at Bell Laboratories it was found that this technique, called "sputtering," could be used to create atomic arrangements different from those normally taken up under equilibrium conditions. Sputtering can "freeze" the material as it is about to change from one atomic structural arrangement to another. Furthermore, it was found that higher than usual superconducting temperatures in various materials could often be associated with these frozen-in atomic arrangements.

NEWS HIGHLIGHTS

Electronic blackboard uses phone lines

An experimental system capable of transmitting blackboard writing via telephone lines for display on a TV screen at distant locations is currently undergoing trials at the University of Illinois.

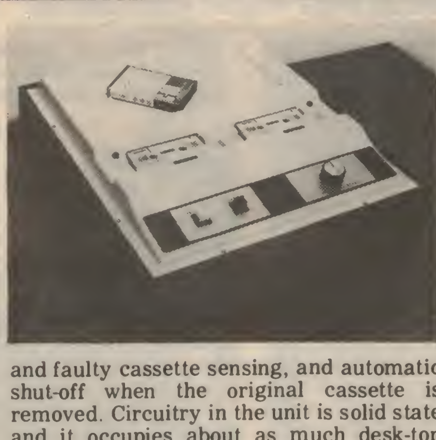
Called an electronic blackboard, the system was devised by Bell Laboratories, the research and development unit of the Bell Telephone System. A major advantage of the new system is that it is far less costly than closed circuit television, the only other comparable system transmitting both audio and visual information instanteously.

The University of Illinois is using the electronic blackboard to transmit engineering classes conducted at its campus in Champaign-Urbana to off-campus locations in Freeport, Rock Island, Peoria and Rockford. The technical trials are being co-ordinated by Bell Labs and Illinois Bell Telephone Company with the university's co-operation.

To transmit handwriting and other information such as graphs or drawings, the instructor writes on the pressure-sensititive surface with chalk as if he were writing on an ordinary blackboard. The handwriting motions are converted to electronic signals and transmitted over the telephone line. At the receiving end, the signals are reconverted and displayed on a TV screen.

The audio portion of the lecture is carried over a second telephone line, via a portable conference telephone already offered commercially and in wide use by Bell System customers. The conference telephone features hands-free operation, a built-in loudspeaker, and facilities for two-way conversation between groups of people.

High speed cassette copier



Philips Industries have released an audio cassette tape copier which can automatically duplicate tapes from the original in less than one thirtieth of the cassette's normal running time.

The cassette copier, manufactured by the Telex Corporation, USA, is designed for simple straightforward operation and can be used by untrained personnel. The original cassette is simply inserted into the copier, automatically turning it on. A blank or used cassette is then placed in the recording compartment and the rewind button pressed to ensure copying from the beginning of the tape. A track selector allows selection of track one or two, or both. The copy button is then pushed, allowing a 30-minute cassette to be duplicated in less than one minute.

The Telex cassette copier automatically erases old material on selected channels, has a fully automatic rewind, end-of-tape and faulty cassette sensing, and automatic shut-off when the original cassette is removed. Circuitry in the unit is solid state and it occupies about as much desk-top space as a standard typewriter. Add-on facilities are available to make up to four more copies simultaneously.

Mr Rod Craig, Marketing Manager of Philips Vision and Sound which distributes the Telex copiers, said that they would find wide application in education, business and in the computer industry.

Self-convergent 110 deg colour TV tube

A new colour television display system for 26in, 22in, and 18in screen sizes with 110deg deflection has recently been announced by the Philips Company. The principal feature of the new system is inherent self-convergence, the only dynamic corrections being to balance out small production tolerances.

Known as the 20AX system, the development is the result of a principle established some years ago in the Philips Research Laboratories. The new system uses a colour tube which produces 3 beams horizontally in-line to excite three vertical colour phosphor stripes selected by means of a vertically slotted mask. A standard neck diameter of 36.5mm enables the electron guns to be positioned for optimum colour purity, and the same quick heating cathodes which Philips introduced last year are used.

The practical realisation of a fully self converging deflection system for large screen sizes became possible with the experience gained by Philips in production of the multi-section saddle yoke which has been used by European setmakers since 1971 for second generation 110° colour. It is expected that the new Philips system will gradually appear in new model European TV receivers to be introduced to the market in the second half of 1975.

US to construct giant radio telescope

A $US76 million project to construct the world's largest and most sophisticated radio astronomy telescope has been approved by the US Government. The site chosen for the new facility, which will incorporate an entirely new concept in radio telescopes, is an ancient lake bed in the Plains of San Augustin, New Mexico, some 7,000ft in elevation.

The project, funded by the National Science Foundation and known as the Very Large Array, is scheduled to be completed in 1981. It will consist of five centrally located buildings and 27 dish-shaped radio telescope antennas, each 82 feet in diameter and 92 feet high and capable of being moved to any of the 100 observing stations along a 37-mile double-track railway system laid out in the form of a "Y".

The facility is designed to provide the most sensitive equipment available in the world, with high speed manoeuvrability and high resolution. It is expected to furnish major contributions to our understanding of the laws of gravity, magnetic fields, the nature of energy-emitting gases between the stars, and the origin and evolution of the universe.

E-Systems Inc, based in Dallas, has started constructing the huge antennas. It was awarded the $US17 million contract to undertake this first phase of the project, which is being managed by Associated Universities, Inc of Upton, Long Island, a non-profit consortium of nine Eastern universities — namely Harvard, Yale, Princeton, Columbia, Cornell and Johns Hopkins Universities, the Massachusetts Institute of Technology, and the Universities of Pennsylvania and Rochester.

—George E. Toles.

Australia's radio pioneers — 2

Realising the strategic value of radio, and as a direct result of the First World War, Australia entered the early 1920's determined to build up an independent radio communications industry. In this, the second of four articles, the author discusses the role played by Australia's radio industry during the First World War, and examines the first steps to establish an independent global outreach.

by PHILIP GEEVES*

Australia had enjoyed her newly-won nationhood for little more than a decade when, in August 1914, she was suddenly plunged into a world war. Among the "urgent imperial services" asked of Australia by Great Britain was the task of silencing the powerful radio stations in Germany's Pacific colonies, including New Guinea, which were capable of relaying instructions to naval raiders. At minimal notice, Australia mustered wireless operators and equipment for island outposts, installed a station at Sydney's Garden Island naval base in four days, and set up monitoring posts. This proud chapter of our wireless history deserves to be better known.

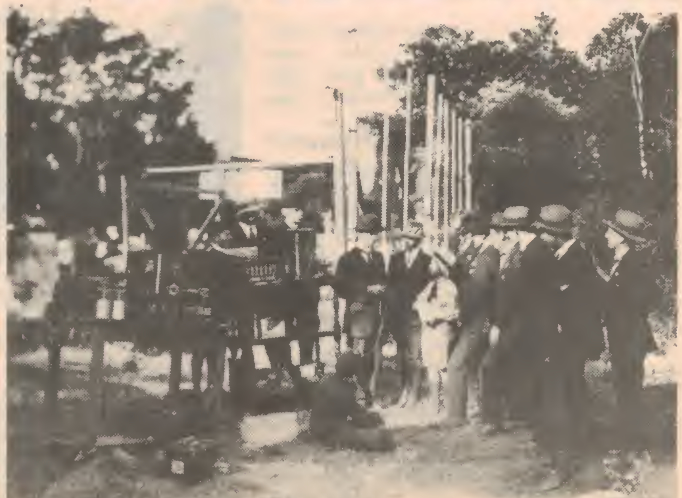
At the outbreak of war the Postmaster-General's Department was operating some twenty coastal wireless telegraphy stations around Australia. Apart from the two 25kW quenched spark Telefunken stations at Pennant Hills and Applecross, all the others were 5kW transmitters designed by the Commonwealth "wireless expert," J. G. Balsillie, and manufactured by the Maritime Wireless Company, the corporate offspring of Father Shaw's Randwick workshop. A special feature of Balsillie's spark discharger was that one electrode was shaped like a nozzle, through which air under pressure was blown. By preventing arcing at the spark gap, the system produced clear and easily readable Morse.

At that time most radio amateurs — officially "experimenters" — maintained receiving stations. Only a minority had the requisite knowledge and affluence to own a transmitter, as wireless components were both scarce and expensive. Indeed, most of the advanced amateurs lived in what were then the "establishment" suburbs. The first impact of the war on the experimental fraternity was a directive to dismantle their equipment and deliver it to the nearest post office for impounding. By May 1915 more than 400 licensed and 200 unlicensed experimental stations had been dismantled. It was not until long after the Armistice that amateurs were belatedly freed from wartime restrictions and again permitted to pursue their hobby. By that time radio telephony was already well advanced and, consequently, its novelty soon captivated Australia's experimenters whose ranks had been swollen by an influx of ex-servicemen with wireless experience.

Quite early in the war it became apparent that the management of radio was creating intense rivalry in official circles. The Navy considered that it should have overall control of wartime wireless and when a Post Office operator unwittingly transmitted an uncoded message concerning a troop convoy, this security breach became a cause celebre. During the latter half of 1915, following Australia's numbing losses at Gallipoli, control of wireless telegraphy throughout the nation passed progressively to the Navy. A year later, with the intention of giving governmental wireless its own manufacturing facilities, the Commonwealth purchased Father Shaw's enterprise, the Maritime Wireless Company, for £55,000. Father Shaw died suddenly in curious circumstances shortly after the money was paid over. A subsequent Royal Commission was extremely critical of the whole transaction and resulted in the dismissal of a former Navy Minister and the resignation of a senator, who admitted receiving money from Father Shaw. The Navy's venture into wireless administration had been something less than auspicious.

Australia's only direct links with the great centres of world power were submarine cables, and destruction of these cables by an enemy raider could have isolated the Australian continent. The Marconi Company had proposed the establishment of an "Empire Wireless Chain" before the war, but indecision on the part of the British Government had caused the scheme to lapse. During the early part of the war, Australia's coastal stations at

*Fellow of the Royal Australian Historical Society.



Below, left; a facsimile souvenir of the first direct wireless messages from Britain in September 1918. The photograph directly below shows the equipment used to receive these messages.

Above, an unusual receiver of the 1920's. Described as a "special 16 valve supersonic heterodyne receiver", it was used at AWA's La Perouse station for the reception of high speed Morse from Melbourne.

Pennant Hills, Applecross and Townsville were equipped with valve receivers for the first time, thus making possible the interception of European transmissions, especially from the powerful German station at Nauen, near Berlin. German propaganda messages were copied daily in Australia.

In 1916, while on a visit to England, Ernest Fisk arranged for a series of test transmissions from the Marconi long wave (14,000 metres) transatlantic station at Caernarvon, Wales. Returning to Australia, Fisk obtained official sanction to use a receiver at his Pymble, NSW, residence, and subsequently at his Wahroonga residence. He succeeded in receiving Caernarvon with a ten valve set employing plate potentials in excess of 300 volts although, as he later wrote, "at that time it was generally considered that no more than three valves could be used in cascade."

After months of experiments, with increasingly better results, Fisk arranged for Caernarvon to transmit special messages addressed to Australia by Prime Minister "Billy" Hughes and Navy Minister Sir Joseph Cook, who had just returned to London from the battlefront. That historic exchange of messages in September 1918 established the practicability of direct wireless communication between Australia and Britain. The achievement also made a profound impression on Hughes, who was later responsible for Australia's decision to create her own global outreach.

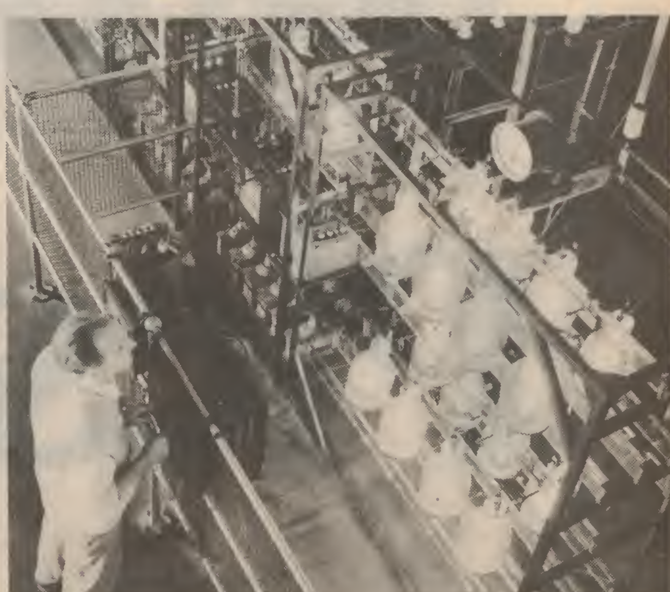
At the Imperial Conference of 1921 Hughes informed Britain, with characteristic vigour, that Australia was not prepared to settle for anything less than a direct wireless link with England. Rejecting a plan submitted by a prestigious British committee for a relay scheme, which would have left Australia dangling at the end of a fragile radio chain passing through countries of dubious stability, the Commonwealth Government commissioned Amalgamated Wireless to set up a direct service to England and, as an expression of faith in the future of radio, acquired a major equity in the company, a partnership that endured for almost thirty years. That same 1922 agreement empowered AWA to take over the operation of coastal radio stations.

At that time, the prevailing technique for long distance transmission was essentially a combination of high power and long wavelengths. The super station planned for Australia's transocean service was to have been of 1,000 kilowatts, with a huge antenna system supported on twenty steel masts, each 800ft high. The capital cost of such a station was considerable and, as Marconi veterans still recall, the atmosphere around these stations was rather eerie; birds or cats seldom ventured near a high power station, where the air fairly crackled with radio frequency during transmission.

To obtain reliable data on reception from Europe, AWA established an experimental monitoring station at Koo-wee-rup, Victoria, in 1921. A puzzling phenomenon soon became apparent. Two daily reception peaks were noted, but the reason was not understood until a rotatable loop aerial revealed that signals from European stations were following the great circle route of maximum darkness. This was confirmed independently by two Marconi engineers who visited Koo-wee-rup in 1922. Later that year, AWA outfitted a Ford van as a mobile laboratory to explore possible sites in New South Wales for the proposed high power station. Locations examined included Campbelltown, Mulgoa, Mount Victoria, Richmond, Singleton and Maitland. Results obtained were very similar, but slightly inferior, to those at Koo-wee-rup.

As these field investigations were proceeding, no one in Australia suspected that the future course of global communication would soon be decided by Marconi's renewed interest in the behaviour of short waves. Marconi himself was surprised at the distances achieved by short wave transmissions when his principal assistants, Franklin and Round, succeeded in designing transmitters using thermionic valves and special reflector antennas at wavelengths below one hundred metres. For obvious reasons, these Marconi discoveries were kept "under wraps," so it was with considerable astonishment that in February 1924 AWA engineers read a cable from Marconi asking them to listen on 90 metres for a station in Cornwall, call sign 2YT. That message was to become the death sentence of Australia's planned transocean wireless service and of Britain's entire scheme for a

Pictured below is AWA's "mobile laboratory" used for site testing for the proposed long wave transocean service. Below, right are transmitter racks at the Beam Wireless Centre in Ballan, Victoria.

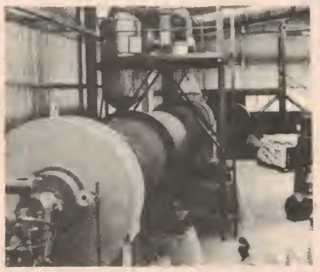


Australia

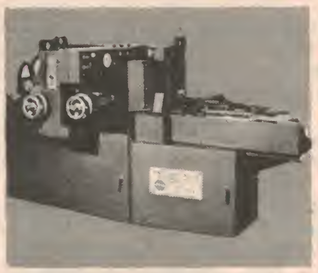
'PABX' — manufactured by Plessey Telecommunications, this private automatic branch exchange system employs crossbar switching and componentry similar to that used by the Australian Post Office in the national telephone network.

Plessey Rodan indicator lamps designed for compatibility with and to enhance the presentation of electronic, electrical and industrial equipment. These indicator lamps are just some of the vast range available from Plessey Ducon.

The 'do-it-yourself' stereo amplifier kit from Plessey Ducon. This simple and easy to assemble kit will provide truly first class reproduction at a cost far below that of equivalent powered units.



Plessey Rola is Australia's largest manufacturer of magnetic materials. Under agreement with B.H.P., Plessey have exclusive marketing rights for hematite and ferrite powders produced from Yampi Sound.



Designed and produced in Australia by Plessey Telecommunications, the 'Computermatic' timber grader completely eliminates the guesswork from visual timber grading. Electronic grading ensures that timber is accurately classified by strength and stability before use.

Plessey Mallory interval timer switch — commonly used in automatic washing machines and electric ranges are supplied by Plessey Ducon located at Villawood, N.S.W.

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long wave relay chain.

There was not a set in Australia capable of receiving ninety metres, so AWA built two immediately, installing them at Willoughby and Vaucluse. One of the engineers involved, Eric Burbury, recalls . . . "to our surprise, at 5.30 the following morning signals were received at good strength and reported by telegram to the Marconi Company." That was just the beginning. A whole series of tests ensued, employing various wavelengths: 25 metres gave the best all round performance.

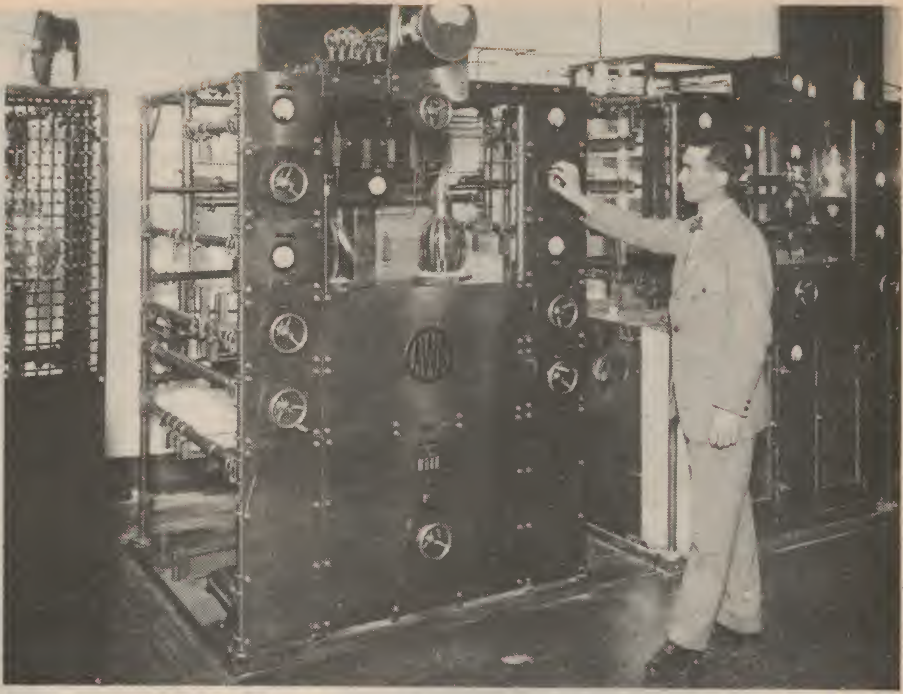
The results were so impressive that in May 1924 Marconi decided to try short wave telephony to Australia. This experiment was also successful, good quality speech being received at Sydney direct from Poldhu, Cornwall. The word "beam" appeared increasingly in press accounts of Marconi's experiments and the bemused public sensed the attainment of yet another technological landmark. Popular writers described beam wireless as "a narrow ribbon of energy girdling the earth like an invisible searchlight."

Yet the discovery of beam propagation created a fine dilemma for the Marconi Company, as well as for the governments with which it was dealing. The beam was still experimental, so no one could really be sure that the results obtained were not merely freakish propagation effects. In Australia, a veteran Marconi engineer, Harold Drake Richmond, was already busy on preparatory work for the long wave station, but the beam breakthrough put the expensive high power scheme into abeyance. After some agonising soul-searching, the crucial decision was made in favour of the short wave beam system. Victoria became Australia's beam wireless centre, with the transmitting station near Ballan and the receiving station at Rockbank.

The service to England was inaugurated in April 1927. The result was a triumph and the beam rapidly became the world's trusted messenger. Indeed, its speed and economy soon created a serious situation for the cable companies, but that is another story altogether.

1927 proved to be a vintage year for Australia's growing international outreach. In September, AWA's 20kW experimental short wave (28.5 metres) transmitter at Pennant Hills launched Empire broadcasting with an ambitious presentation by Australian artists and notables. The program was intercepted by the BBC and re-broadcast to millions throughout Britain. Before the year ended, a total of five global programs had been transmitted in this way, and Australia's characteristic accent, as well as the kookaburra's laugh, were familiar in many countries long before the BBC established Empire broadcasting. Much of the credit for VK2ME's successes belongs to veteran AWA engineer, S.M. Newman, who still lives in Sydney.

Following the spectacular success of beam wireless, it was inevitable that international duplex telephony would be the next refinement, and after considerable experimentation it became a reality for Australia in 1928. VK2ME, the powerful "maid-of-all work," was again pressed into service. On



Pictured above is AWA engineer Sydney Newman at the AWA transmitting facility, Pennant Hills, 1928. Below is a reproduction of one of the first movie frames transmitted to England in 1934, showing victorious airmen Scott and Black with aviatrix Jean Batten.

October 31, 1928, a select group of VIPs and pressmen gathered at AWA's Sydney office to exchange greetings with confreres in other countries, merely by speaking into a domestic telephone. And although male voices dominated those tests, it should be mentioned that Mrs Albert Deane, the American wife of an Australian-born film executive, had the distinction of being the first woman in the United States to converse with Australia by radio telephone. The regular radiophone service to England was opened with due ceremony on April 30, 1930.

The next logical step was a facsimile service, a facility with many applications, including news photographs, cartoons, fashion sketches and fingerprints. The first experimental essays in the genre shuttled between England and Australia in 1929, but it was not until October 1934 that AWA opened a fully fledged picturegram service. Among the earliest transmissions were prints of movie frames from the newsreel coverage of an England-Australia air race. In London, these radio pictures were reconverted to movie film and screened in British cinemas the next day.

This article has merely established the guide posts for Australia's early overseas radio outreach. It should be added that not a little of the public pressure for improved communications stemmed from a vocal lobby of radio amateurs and pioneer broadcasters, to whom only passing reference has been made. Our next article will highlight the sterling work of Australia's amateurs during the 1920s, as well as sketching the origins of our broadcasting system.

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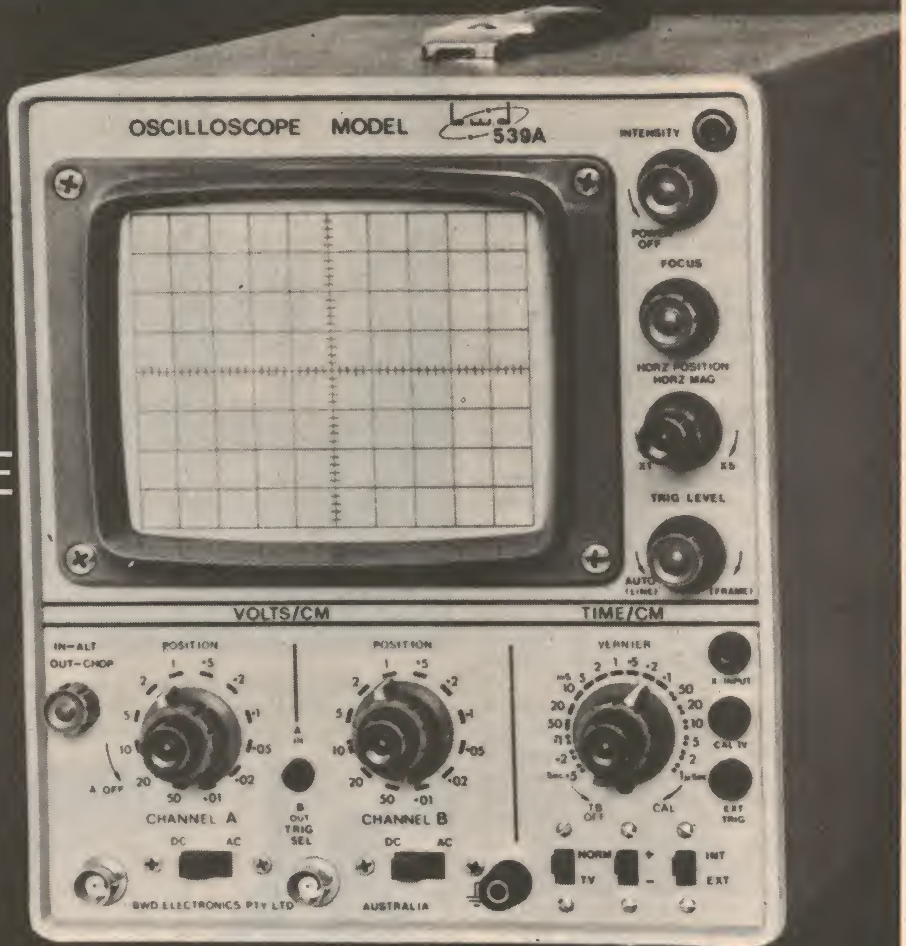

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Man-portable radar for personnel detection

Intruder detection is one advanced field of modern electronics that is currently receiving a lot of attention. Characteristic of this trend, and the trend towards miniaturisation, is a new portable radar system developed by the Marconi Company. Weighing only 11.5 kg, the new radar is designed to be carried and operated by one man.

by A. C. PRIOR* and K. A. J. WARREN**

Figure 1: the complete unit, pictured mounted in the tripod mode, is lightweight and portable.

There are many different situations where an intruder must be detected by a patrol or security guard under conditions in which his normal visual or aural facilities are obscured by, for example, fog, smoke, darkness or noise. Various aids are available for use in such conditions — including image intensifying devices, thermal imaging and radar. One such radar of advanced design is capable of being carried and operated by one man to provide an all-weather detection and ranging capability against moving targets.

The complete equipment is shown in Figure 1. It consists of a radar transmitter-receiver with an integral flat antenna array mounted on a tripod with a battery suspended beneath. Moving targets are detected by listening on headphones for their Doppler frequency, and are recognised and identified from characteristic noises in the headphones. The range of a moving target is indicated by direct readings from illuminated scales on the transmitter-receiver, after a ranging control has been adjusted for maximum signal strength.

When operated in the patrol mode, the transmitter-receiver is mounted on the operator's chest and the battery carried in a pouch on his back. The tripod can be folded for transport on a patrol's shoulders in a military application. To minimise physical fatigue, the all-up weight of the equipment has been restricted to 11.5 kg, including a primary power supply which is adequate for overnight operations.

It was realised very early in the development of the system that the ruggedness of the equipment must not be compromised by the very stringent weight requirement. In a military application, survival under forward-area conditions is essential; accordingly the design philosophy has been based on the premise that such compact lightweight equipment would be treated with less care than bulkier earlier counterparts.

The transmitter-receiver container is vacuum formed from superplastic zinc-alloy, giving a seamless unit of great strength combined with low weight, high rigidity and resistance to impact. The antenna array attached to the front of the case is covered with a radome of sandwich construction of sufficient strength to withstand impacts while cushioning their effect on the array below. The outer skin is scuff-proof and virtually immune from water absorption.

The radar employs FMCW (frequency modulated carrier wave) and pulse modulation of the transmitted signals for the purposes of searching for a moving target and finding the range of that target. Use of different modulation patterns enables the radar to function efficiently as regards power consumption from the battery, and in this particular case a minimum of eight hours' radar operation is possible between battery changes.

The radar performance when searching for a target moving in the vicinity of clutter is slightly worse compared with those systems involving a search through the radar detection range with a single gate or a bank of gates. However, the increased battery life compared with the more sophisticated systems far outweighs this loss in performance.

The antenna takes the form of a planar array consisting of a number of vertical stripline linear arrays energised by a tapped transmission line power divider. Such an array offers a very convenient means of production by etching techniques and is both lightweight and rugged. The nature of the stripline substrate ensures a high degree of resistance to crushing and only a simple radome is necessary to protect the radiating surface from superficial damage. The array is curved such that the plane containing the radiating elements lies on a constant radius of curvature.

Considerable attention has been paid throughout the development of the radar to the ergonomic aspects of its use, especially in the patrol mode. The load of the radar transmitter-receiver and the battery package is equally divided between the operator's chest and back, and is prevented from moving relative to his body by a special-purpose carrying harness. This split-load concept minimises operator fatigue when the equipment is carried for a long period. The radar transmitter-receiver interface to the carrying harness is designed for quick release so that in the military application the operator can move rapidly into cover, removing the radar from his chest for use in an exposed position if necessary.

Choice of headset for the radar has been dictated primarily by the need to detect the Doppler returns from low-speed targets, requiring a usable response at frequencies down to about 50 Hz. Bass boost is used in the audio amplifiers to ensure a sensibly flat overall frequency response from phase detector output to the aural nerve of the operator. The chosen headset will fit under many designs of helmet so that the operator is still able to retain protection from close-range attack, and two acoustic valves are provided so that he need not be isolated from his surroundings. In military applications, these valves provide protection for the user's eardrums against nearby gunfire, even when open.

The needs of military applications have governed the design of the tripod. Lightness and strength are essential, as is the need to deploy the tripod quickly and silently under cover of darkness on rough or sloping terrain. As a result a very stiff design has been produced, the length and angle of each tripod leg being independently adjustable for maximum flexibility of use.

The radar is designed to operate on any of the standard of secondary batteries from the 24 V series designed for the Clansman series of radios. This allows maximum choice of power supply in a tactical environment.

* Marconi Radar Systems Ltd, Chelmsford, England.
**The Marconi Company Ltd, Chelmsford, England.

Digital television: the way to the future?

Although not without their difficulties, digital television systems offer considerable advantages over conventional analog systems; advantages in terms of distortion, video noise, signal recoverability, and signal processing. This article discusses these advantages and examines the future applications of digital television systems.

by C. W. REIS*

It does not seem so very long ago — a year or two at the most — when usage of the word "digital" and all that it implies was mainly the prerogative of the computer engineer. Within the realm of broadcasting it was unlikely to be used outside the development laboratory. But now, certainly so far as television is concerned, it has suddenly become the "in" word and assumed a new importance.

One might well ask why and how this has come about. Present television systems in the United Kingdom, and elsewhere, have been carefully and skilfully built-up over the years using analog methods which are now firmly established. Then, providing the viewer is so situated that he is able to receive a reasonable share of the transmitted signal (not always the case, unfortunately) everybody seems reasonably happy. So why go digital? Why rock the boat?

The answer of course, is quite simply that there are considerable advantages to be gained from the use of digital techniques which hitherto could not be realised because the technology, in the practical sense, is only now just becoming available. To understand how these advantages arise let us examine what a digital signal is and how it differs from the time-honoured analog technique.

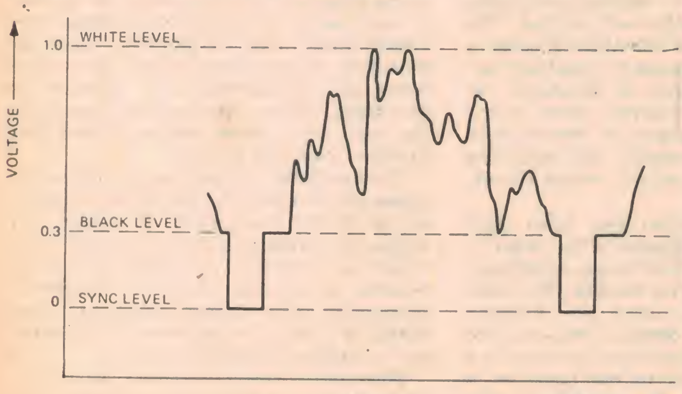
The voltage variations that occur during a line of video waveform (Fig 1) are a representation of the spatial variations of light level that exist along a horizontal line in an image of the original scene as it is traversed from left to right by the scanning beam in the camera (or telecine). The essential points to notice are that the wanted information has been expressed in terms of an absolute voltage level and that the correspondence between these two entities, light and voltage, is continuous. That is to say, in relation to the permitted extremes of white level and black level, a range of 0.7V in the case of that shown in Figure 1, the video signal may be required to occupy and maintain throughout its various stages of existence any of an infinite number of intermediary levels. This implies that apart from gamma-correctors, which are necessary to correct for distortions introduced by camera and display tubes, all items of signal handling equipment, be they amplifiers, switchers, attenuators, transmitters or whatever, must be designed to be as linear and as stable as possible. Any departure at all from strict linearity, or any drift that occurs once the system has been set up, means that some parts of the reproduced picture will be portrayed with the wrong brightness. This constitutes distortion and, in general, once the true relative signal has been lost it is lost for good. There is no easy way of assessing and correcting this error.

Another problem that has to be reckoned with in dealing with voltage dependent analog signals is noise. Video noise is a term used to include all manner of unwanted signals which in different ways become added to, and for the most part are inseparable from, the wanted signal. Other things being equal, the limiting factor which determines the quality of any signal at the end of a transmission path is its signal-to-noise ratio. As with non-linear distortion, once an analog signal has become contaminated with noise there is little or nothing one can do about it.

A digital signal expressed in binary form, on the other hand, is not level dependent to anything like the same extent. It consists basically of a succession of pulses and spaces. These pulses are of fixed amplitude and therefore such a signal can only occupy one or other of two possible levels. This follows from the fact that at any given instant in time only two alternative conditions can exist — either a pulse is present or there is no pulse present.

In a digital system, the meaningful information to be transmitted is contained in the arrangement of pulses and spaces. It is the order in which they occur that is the key to their meaning, just as it is with the dots and dashes of the morse code. However, in the

*Independent Broadcasting Authority (IBA) London.
Reprinted from "Sound and Vision Broadcasting," published by Marconi Communication Systems Limited.



Decimal	Binary
1	00000001
2	00000010
3	00000011
4	00000100
5	00000101
6	00000110
7	00000111
8	00001000
9	00001001
10	00001010
15	00001111
20	00010100
25	00011001
50	00110010
64	01000000
114 (64 + 50)	01110010
178 (128 + 50)	10110010

Fig 1 (above): an analog video waveform. At right is a table listing some 8-bit binary numbers. All numbers up to and including 255 may be represented in 8-bit binary form.

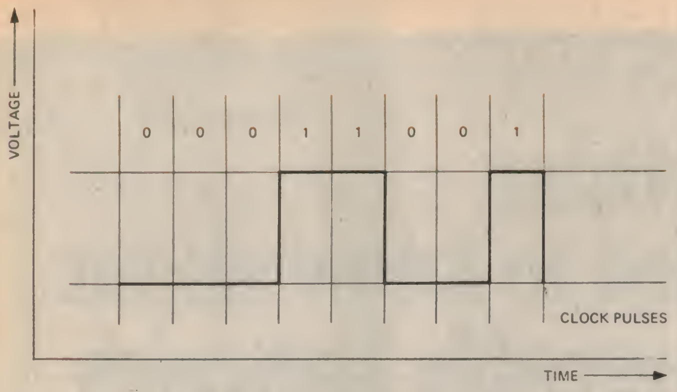


Fig 2: a digital waveform representing the decimal number 25. In 8-bit binary notation this is written as 00011001.

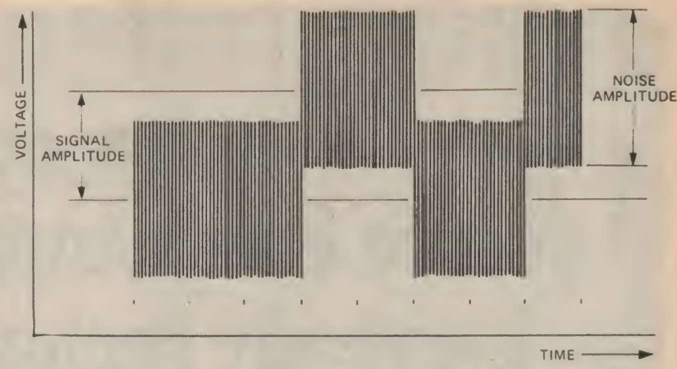


Fig 3: the same waveform as shown in Fig 2, but with more than its own amplitude of noise added.

case of television the range of different light levels comprising the original scene are represented by another code, the binary code. This is a system of numbering based on the radix 2 instead of the usual every day decimal system based on ten. Only the numerals 0 and 1 are available for use in binary. These are known as binary digits or bits for short, and they can be arranged to represent any numerical quantity. Some of these are given in the table on page 36 from which it will be seen that binary numbers are not as compact as their decimal equivalents. But, though they are hardly suitable for general use, for the purposes of our present discussion they have one outstanding advantage — they can be represented directly by a voltage waveform in which pulses and spaces respectively take the place of the 1s and os. By way of illustration such a waveform, representing the decimal number 25, is shown in Figure 2.

If then, in a digital system, the equipment chains are called upon to deal with signals having a type of waveform in which information exists at precisely two levels only we can afford to be less strict with linearity requirements. Why make provision for information at intermediary levels if it is entirely absent there? The sole interest now is whether a pulse exists or not and, so long as the transition between pulse and no pulse can be carried out fast enough, the waveform can be handled without fear of distortion, other than by noise. What is more, should the stability of some of the equipment in the chain be such as to allow the level of signal to drift somewhat, no harm will be done as pulse amplitude is unimportant. All that matters is being able to recognise the order in which the pulses and spaces, the 1s and 0s, occur and this is in no way affected by variations of amplitude.

Noise, of course, will ever be a problem to the electronics engineer but here again the digital system scores greatly. It is very much more tolerant of noise for exactly the same reason. In fact, often just by amplifying and clipping, the noise on a digital signal can be effectively removed. Even under extreme conditions where the noise amplitude exceeds that of the signal (Fig 3), which in the analog case would render it quite unusable, so long as the pulses and spaces can still be identified with certainty it is possible, using a rather more elaborate technique, for the complete signal to be regenerated and so appear at the end of a transmission path virtually without impairment. Furthermore, to avoid cumulative effects this can be repeated any number of times in succession.

A digital system is a truly numerical system and equipment which handles digital information, like calculators processing numbers, is precise and unambiguous. The situation cannot exist for it to work well or badly; either it works, or it does not.

So much for what a digital system has to offer. But unfortunately, it is not without its problems; there is a debit side to the balance sheet.

It is assumed that, within the foreseeable future, signal generation in cameras and telecines and the reconstitution of the picture image by means of cathode ray tubes will remain analog processes. To obtain a signal in digital form thus calls for an analog-to-digital converter (ADC) and, conversely, before a digital signal can be displayed on a picture monitor or receiver it must be passed through a digital-to-analog converter (DAC). The conversion process from analog to digital begins by sampling the analog signal at a rate compatible with the passband of the signal being sampled. The well-known theorem by Shannon requires that for the UK bandwidth of 5.5MHz the sampling rate should not be less than 11MHz. Preliminary studies by the IBA, however, showed that for a colour signal it is advantageous if the sampling rate be raised to the third harmonic of the subcarrier frequency, ie, approximately 13.3MHz.

The samples, which at this stage comprise a succession of narrow pulses of differing amplitudes, are subsequently translated into binary form. However, for this to take place they must first be quantised. That is to say, they must be rounded off to the nearest whole number on an arbitrary scale representing the magnitude of the applied signal. Obviously the number of quantising levels on this scale is important. If there are too few the resulting pictures will appear contoured (Fig 4); if there are too many we shall be transmitting unnecessary information. It has been found experimentally that something of the order of 250 levels is a good compromise. Each sample is therefore expressed as an 8-bit binary "word" as this is the minimum standard word length that can be used for writing any number between 0 and 255, as is apparent from the table.

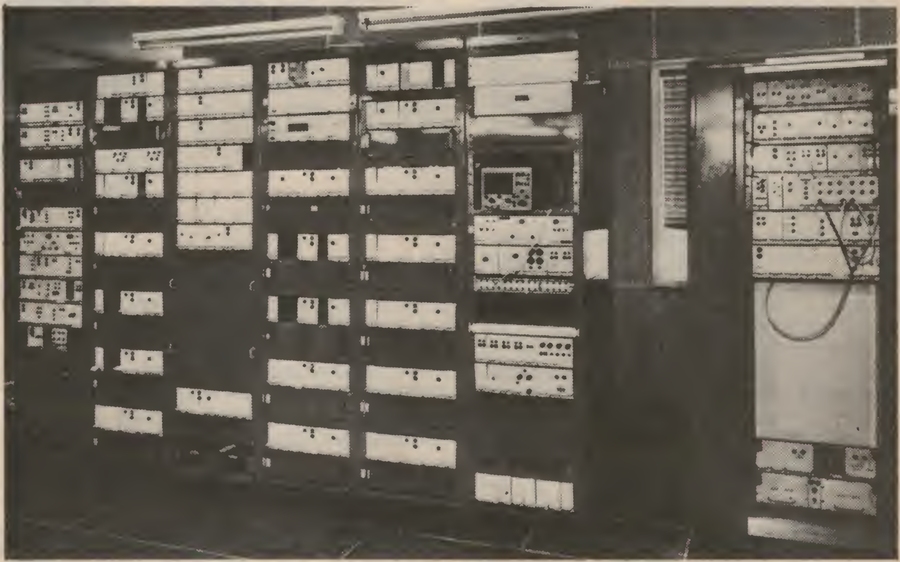
Now for a shock: If the sampling rate is 13.3MHz and the word length of each sample is 8 bits then the channel carrying such a signal must be capable of responding to $13.3 \times 8 = 106.4$ megabits per second. From this the system bandwidth, which should not be less than ¾ of the bit rate, amounts in round terms to 80MHz! This is practically 15 times as much as is needed to handle the signal in its analog form and certainly takes some of the gilt off the gingerbread. However, one way of getting round this for a number of closed circuit applications, particularly within studio centres, is to split the information into, say, eight separate 13.3MHz paths or circuits. In this way the bit rate in each path is proportionately reduced.

About three years ago the Experimental and Developmental Department of the Independent Broadcasting Authority (IBA), recognising the potential benefits to be derived from digital technology, started working in this field. In the first instance, a project was chosen which would enable some of the basic digital techniques to be tried and tested and at the same time yield a result that was likely to compare advantageously with existing analog equipment. The result was an experimental digital field-rate standards converter, DICE (Digital Intercontinental Conversion Equipment), which was successfully demonstrated and put into operational use towards the end of last year. It accepts an American 525-line, 60 field NTSC colour signal, and provides an output signal on the European standards of 625-lines, 50 fields encoded to PAL or SECAM colour as required. Eventually the system will be made bi-directional (ie also 625 / 50 to 525 / 60).

With regard to system performance, it is generally accepted that, ignoring effects which arise from the difference in scanning standards (line structure and flicker), the output is practically indistinguishable from the input. Consisting as it does of just two slim 19in cubicles, the converter is much more compact than any other converter of comparable performance and it has only a single operational control — the hue control for the NTSC input signal. Setting up, therefore, really is minimal. And because it is virtually a special purpose, custom-built digital computer its performance is absolutely consistent.

The prototype equipment is now in regular daily use at the studio centre of Independent Television News in London where it is playing a valuable part in a satisfying global demand for better quality in the satellite exchange of programmes between countries. It is also available to enable taped programs, which are made for both American and United Kingdom audiences, to be offered at a much higher technical picture quality to the home market.

*Fig 4 (above): the effects of quantising to eight levels is shown at left and to sixteen levels is shown at right. Below is an early NTSC / PAL-SECAM converter. The latest digital converter **consists of just two slim 19" cubicles.***



Another innovation which has been recently given extensive field trials in the London region is a means of extending to the viewing public a system of data transmission whereby 50 different "pages" of written information can be simultaneously broadcast along with the normal television pictures. Each page can contain up to 22 lines of 40 characters, or roughly 120 words, providing such information as continuous accurate time checks, weather forecasts, national and local news, stock exchange prices, television and radio program information, advertising announcements, etc. These written messages would be selected by the viewer for display on his domestic UHF television receiver, either in place of the normal transmitted picture or superimposed on it. The receiver naturally needs to be suitably adapted for this use, either by means of a separate add-on unit or, more cheaply, by an internal modification.

Of course, before such a public data service could begin, approval would have to be obtained from the Ministry of Posts and Telecommunications. However, it is anticipated that once a firm decision is made to go ahead, British industry would be able to produce suitable adaptor units for use in conjunction with currently available black-and-white or colour television receivers. The price of such adaptors, cannot yet be estimated accurately, but is likely to be in the range of £35 to £120.

The IBA's code word for this new system is ORACLE (Optional Reception of Announcements by Coded Line Electronics) — and the method of coding is digital.

The data channel provided in the experimental equipment is open only during the active period of one or more lines within the field blanking interval, each period being 51.7uS, repeating at the rate of 50 times per second. It is of course, also limited by the same constraints as is the video signal with regard to bandwidth etc. During each data transmission period of 51.7uS one segment of text, representing up to ten characters (ie one quarter of a line of written information), is transmitted together with its address code. This address indicates to the receiving unit the exact position on the screen and for which page the information relates.

At the receiver, the ORACLE adaptor separates the data signal from the television signal and passes the data, in 51.7uS "packets," into an intermediate store. The address code is then used to insert the information at precisely the right moment into the main store where the complete page of information is assembled and held ready for display. At the studios, it is anticipated that the various pages would be kept updated by an editorial team working in conjunction with a central computer to collate the information for insertion into the television waveform prior to transmission.

Although the foregoing remarks were restricted to television, it must be said that sound signals stand to benefit from digitisation in exactly the same way. In fact the British Broadcasting Corporation have done much interesting work on this subject and have proposed the system known as "Sound in Syncs" whereby the sound accompanying a television programme is transmitted as a digital signal within the line synchronising interval of the video waveform. In this manner it becomes integral with the vision signal and does not require a separate channel.

Such then, in very broad terms, is the state of the art at the present time. To what extent is it possible to peep into the future?

It is interesting to note that the Post Office is reported as having a number of different types of digital transmission systems under development. These include 120 megabits per second circuits using 4.4mm diameter coaxial cable for television networks, and an 11GHz microwave system. Other long-term developmental work includes research into optical fibres and millimetre waveguides, both of which have very great potential in terms of carrying capacity. Back in the studio, one important piece of equipment which would undoubtedly pay high dividends for being digitised is the video tape recorder. A digital version would not only be easier to operate, but would also make possible the production of multiple copies without degradation in picture quality.

It could be argued that the greatest advantages of digital technology, with its tolerance to waveform distortion and its high noise immunity, will only be harvested if in some way it becomes possible to retain the signal in digital form throughout the entire transmission process from camera to receiver. The difficulty, obviously, is all that bandwidth.

Perhaps one day, when direct satellite broadcasting using the super-high-frequency bands has become a reality, analog broadcasting methods will be looked upon with the same sort of affectionate curiosity as is the steam engine today. It is an interesting thought, anyway.

Special offer calculator is versatile, easy to use

As you can see from the advertisement on the opposite page, E-A readers are currently being offered the Rodan type 80N electronic desk calculator at a special low price, from Plessey Professional Components. Having had the opportunity to put a sample unit through its paces, we can verify that the calculator being offered is particularly versatile and easy to use.

The Rodan 80N electronic calculator being offered to E-A readers at a special price. It offers the four arithmetic functions, a constant for multiplication, division and squaring, and an intriguing underflow system.

The Rodan 80N calculator is a fairly compact desk calculator, not all that larger than one of the miniature pocket types. It measures 12.5 x 20.5 x 4.5 cm, and is housed in a case of grey shock resistant plastic. Being compact rather than miniature, its readout display has figures of fairly generous size — about 1cm high, which improves visibility. The keys are similarly of generous size, making them rather more suitable for adult male fingers than some of the keys on miniature machines.

Although basically a four-function machine, the 80N offers features not often found on many machines of this type. It can perform chain multiplication and division, multiplication and division by a constant, and raising to an integral power. It also features a fully floating decimal point, an automatic underflow system to preserve the significant digits if the results of a calculation exceed the machine's capacity, suppression of redundant zeroes to reduce readout ambiguity, and a system whereby the readout "fades out" after about 15 seconds following an entry or the result of a calculation, to extend battery life. In the latter case the information is not lost, and may be immediately restored merely by a touch on the "equals" key.

The readout display uses seven-segment gas discharge tubes, which are easily read from a distance of many feet. The numerical part of the display is of eight full digits, with a ninth display tube used to indicate negative sign and underflow.

A particularly attractive feature of the 80N is its keying syntax — i.e., the order in which the keys must be pressed to enter in a calculation. With some calculators, this can be rather different from the way in which one tends to write down the problem, and as a result it can take quite a while before one gets sufficiently proficient with the machine to take full advantage of it.

In contrast, the keying syntax of the 80N calculator is virtually identical with normal arithmetic notation, so that there is nothing to re-learn. For any of the four basic functions one simply keys in the first number, then the function key, the second number, and finally the equals sign.

Of course there is a clearing or "C" key which must be pressed before starting any new calculation, to "wipe the slate clean". And if one is aware of making an error in keying in a number, this may be cleared by using the "CE" key and keyed in again, provided that the number has not actually been entered by pressing a function key.

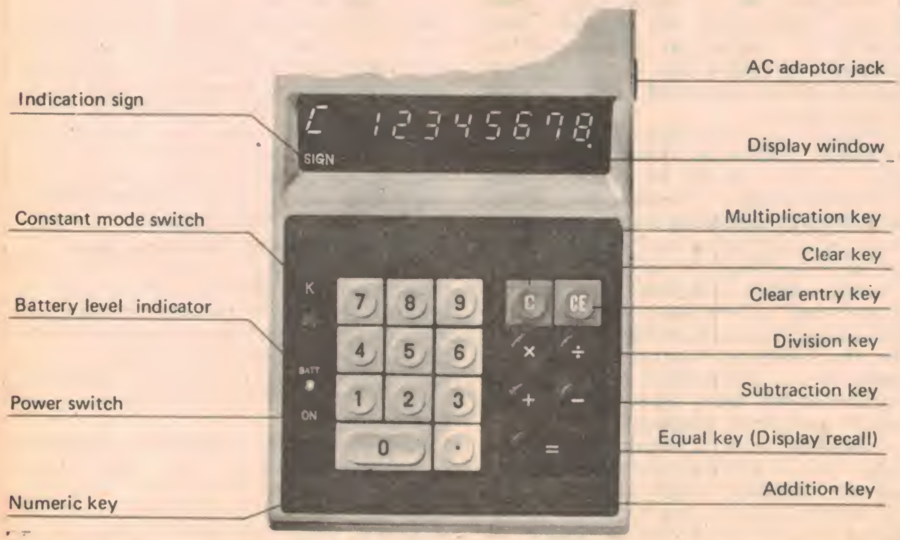
An example of straightforward addition and subtraction should illustrate how simple the calculator is in everyday use. Below are the input steps and the display readout for the calculation 1.234 + 5.67 — 1.2 = 5.704:

Input Steps	Display
c	0.
1.234	1.234
+	1.234
5.67	5.67
–	6.904
1.2	– 1.2
=	5.704

Simple multiplication and division are carried out in similar fashion. For chain calculations there is no need to press the equals key for each intermediate step, even if progressive answers are needed. These answers are automatically displayed as soon as the next arithmetic function key is pressed. This is illustrated in the following example, which shows the calculation 3.14 x 1.4142 x 456 = 2024.9081:

Input Steps	Display
c	0.
3.14	3.14
x	3.14
1.4142	1.4142
x	4.440588
456	456.
=	2024.9081

The constant facility of the 80N is brought into operation by sliding the constant mode



This illustration clearly shows the various function keys of the Rodan 80N calculator, which is particularly easy to operate.

switch to the upper or "K" position. This is used for multiplication and division by a constant, and calculation of integral powers and reciprocal powers.

Multiplication by a constant is a very useful facility for such tasks as sales tax calculation, percentage discounts, and so on. In electronic work it can also be very useful for working out the reactance of a coil or capacitor at different frequencies, or the value of a coil or capacitor to provide any desired reactance at a known frequency.

After having set the constant switch to the "K" position, it is merely necessary to enter in the constant, followed by the multiplier function key. To multiply any number by the constant thus stored, it is simply a matter of keying in the number, followed by the equals sign. This is shown by the following, which uses "260" as the constant:

Input Steps	Display
C ↑K	0.
260	260.
×	260.
1.5	1.5
=	390.
17	17.
=	4420.
123	123.
=	31980.

To raise a number to an integral power, the same procedure is followed, except that there is no need to key in the number a second time, or any further times. The number is simply stored as a constant, along with the multiply function; pressing the equals key once then gives its square, a second time its cube, and so on. This is shown below, where the square and cube of 3.14 are calculated:

Input Steps	Display
C ↑K	0.
3.14	3.14
×	3.14
=	9.8596
=	30.959144

Division and chain division are very similar to multiplication, as is division by a constant. In the latter case the calculator automatically stores the number which follows the division function key, so that the keying order is completely normal. There is no need to key in the divisor first, as is necessary with some machines.

Reciprocal powers may be calculated as before, merely by keying in "1", the division function, the number concerned, and then repeatedly pressing equals.

An intriguing feature of the 80N is its underflow facility. When the result of a calculation exceeds the machine's nominal 8-digit capacity, it automatically drops whatever number of least significant digits are needed in order to fit in the answer on the display. At the same time it locks up, and indicates that underflow has occurred. You can't go any further with that particular calculation, but at least the machine lets you know the eight most significant digits of the last answer it got! This appears to work even if the answer is in the order of 100,000,000,000,000.

As you can see, the Rodan 80N is a very easy machine to use, and quite versatile. It would appear to be good value for money at the special offer price of $44.21 including sales tax, and even better at $38.44 for students able to provide an exemption form. An optional nickel-cadmium power supply costs $14.80 extra. (J.R.)

Design for a PAL-S colour television decoder

Here is the first of two articles written especially for the keen experimenter anxious to start working on the construction of a colour TV receiver. It presents a very interesting and practical design for the important colour decoder section, which is a logical place to start with any such set. The author has employed readily available discrete transistors and a circuit which uses virtually no special parts except for a 4.43MHz crystal. If the design attracts as much interest from readers as we think it should, we may be able to publish further articles by the same author, describing other receiver sections.

by ANDREW PIERSON

With the date drawing near for the official commencement of colour television services in Australia, many electronics enthusiasts have been enquiring about the possibility of being able to build their own colour receiver. The feasibility of such a project will be considerably influenced by the motives behind the desire to build. If these are purely financial, the total cost of a build-it-yourself receiver should ideally fall short of the purchase price of an equivalent commercially built unit by a margin sufficient to compensate the constructor at least partially for the labour he has put into the project.

If the motives are directed toward gaining practical experience or just the achievement of having built a colour television receiver, the cost assumes less importance, but it would still leave a nasty taste in one's mouth to end up paying more than the cost of a ready-built unit off the showroom floor.

But why should the total bill for all components in a colour receiver be more than the cost of a completely assembled set? The answer is that in order to obtain the many specialised items (e.g. the tube, deflection yoke and convergence assembly, etc.) we would have to purchase them as spare parts for an established commercial receiver. Present prices on spare parts for black and white TV receivers show that the cost to the manufacturers for these components must be only a small fraction of what we have to pay, otherwise they just couldn't make TV receivers economically. And there is no reason to assume that the situation will be very much different for colour sets.

One way to reduce the overall project cost is to completely design a colour TV receiver from the ground up, and use only a bare minimum of specialized components. A manufacturer may solve a certain circuit design problem by using, for instance, a specially constructed transformer. For a production run, the average cost of these devices may be quite low. However, they will be subject to a large mark-up when placed on the spare parts market, and it may be more profitable for us to use a few low-priced semiconductors to do the same job. Where specialized components are unavoidable, doing a deal with (say) a transformer winding firm may prove more profitable than buying a particular spare part.

The design of a colour TV receiver has always been an attraction for me, and I have set out to produce a receiver that is primarily orientated toward small-scale construction. This means a reasonably flexible design, using readily available components. The total cost will be kept as low as possible, consistent with a reasonable standard of performance. This would be defined as the ability to produce stable, good quality colour pictures in medium to strong signal strength areas with no particular local problems. Some of these would be severe impulsive noise interference, close proximity to strong sources of RF (e.g., taxi base transmitters) with frequencies adjacent to local TV channels, and constantly changing multiple path reception (e.g., aircraft flutter).

EDITOR'S NOTE

The design presented in these articles is intended purely as a guide for experienced amateurs wishing to build a colour TV receiver on their own initiative. A complete receiver of this type is a complex piece of equipment, whose construction involves not only components worth hundreds of dollars, but a large amount of time and effort. We do not recommend such a project to those without a solid grounding in both theory and practical electronic equipment construction. Because of the specialised nature of the articles, neither Electronics Australia nor the author will be able to supply information on colour TV receiver design or construction further to that published, or in advance of material which may be published in future issues. Similarly we regret that we will not be in a position to assist readers privately with problems they may meet in constructing a colour TV receiver based on the designs presented.

In common with all developmental projects, it is very difficult to specify a time limit for completion of all the receiver sections. There are a large number of variables at work, not the least of which are component supply problems. Because the tube supply position has not yet stabilized, it would seem prudent to commence with the signal processing circuitry, and leave the CRT display section till later when a wider choice of relevant components is available.

My arrangement with "Electronics Australia" is that the articles will be published as they are completed, and as space becomes available. They are published primarily for experimenters' information, although the end object is to produce a cheap, flexible colour TV receiver. Note that this does not necessarily mean a simple design. One can afford to be fairly generous with low-priced transistors which cost less than a reasonable size electrolytic!

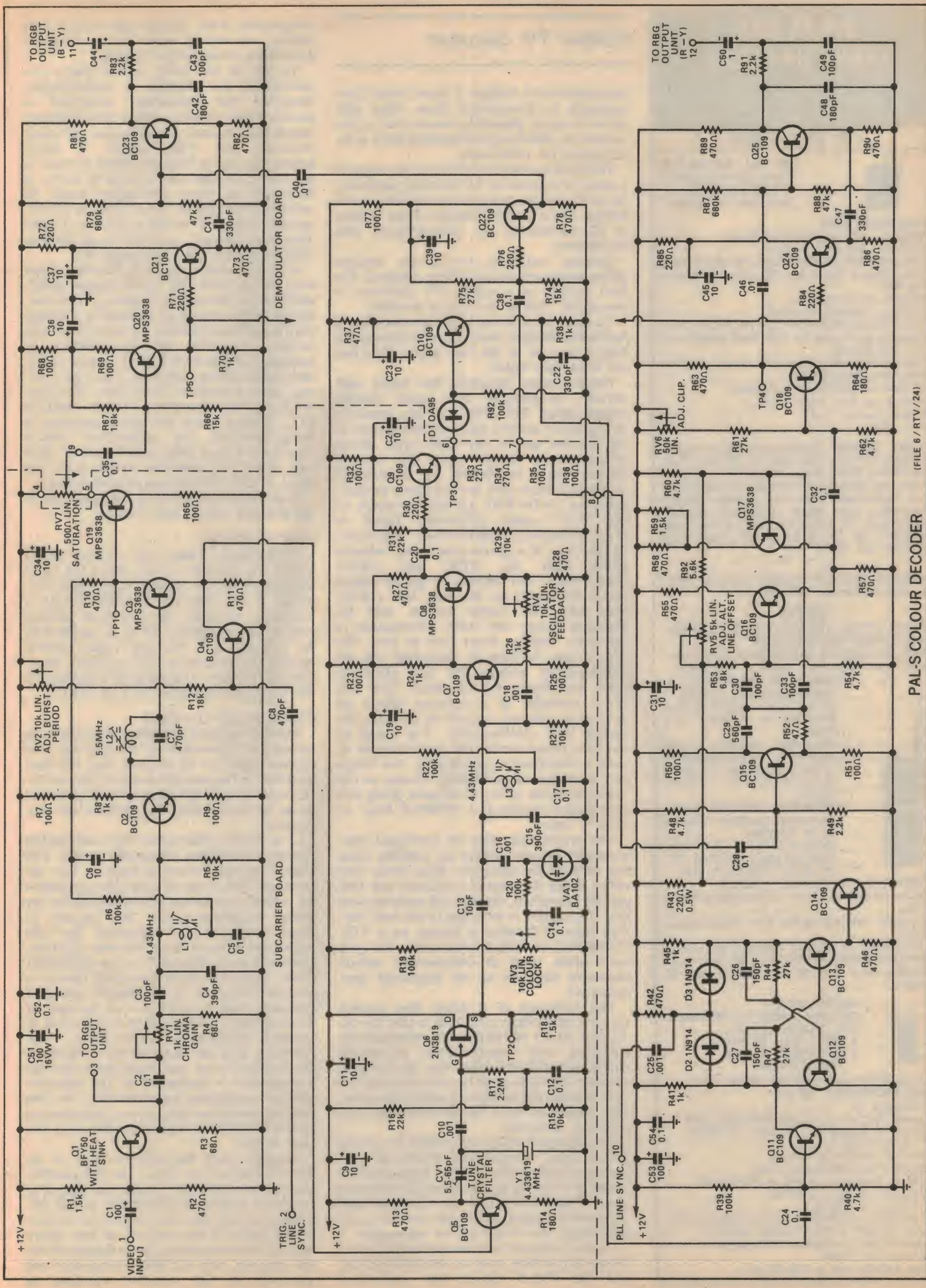
However, there are some characteristics which should not be sacrificed for cost. For instance, I would rather specify a circuit costing $10 which was 100pc reproduceable and simple to align than one costing $7 which had production and alignment problems. There is nothing worse than having to hack into a newly finished PC card because the design could not accommodate normal parameter spreads. It's also comforting to know that the alignment procedure is going to proceed exactly as the text says.

Enough of the design of this receiver has unfolded for me to be able to assure you of one thing — most sections are definitely NON-STANDARD and represent radical departures from commonly accepted practices, so if you are contemplating the construction of an colour TV receiver, it would be advisable to wait until the series is completed before you make your final decision.

When compared with the 'state of the art' receivers which will appear on the commercial market in the near future, this receiver design may appear somewhat 'backward' because of the use of discrete components where a commercial manufacturer will use a specialized IC. This decision was taken only after a great deal of thought on the subject. The first reason for preferring discrete components is the supply problem associated with specialized IC's. Certain types have become obsolete already — and colour TV hasn't even started yet. And what of availability in the future, when spares may be required? Basic devices like BC109 and 2N3638A transistors will be around for a long time, and repairs to discrete component equipment will generally be cheaper, also.

The second reason is that most of these IC's are designed to operate in circuit configurations relating to a specific

The circuit of the author's decoder is shown on the page opposite. Designed specifically for home construction, it uses readily available discrete components throughout.


PAL-S COLOUR DECODER
(FILE 6 / RTV / 24)
SUBCARRIER BOARD
DEMODULATOR BOARD
VIDEO INPUT
TO RGB OUTPUT UNIT
TO RGB OUTPUT UNIT (B – Y)
TO RBG OUTPUT UNIT (R – Y)
TRIG. 2 LINE SYNC.
PLL LINE SYNC.
+12V

Colour TV decoder

manufacturer's design. I have found that attempts to incorporate these chips into other circuitry generally means that a fair number of additional components have to be employed for interfacing.

The third consideration lies in the value of a piece of equipment for training purposes. In an IC design, many circuit functions are hidden, but a discrete design allows access to all waveforms for measurement and instruction.

Having outlined the basic design philosophies which have been adopted, the first section of a colour TV receiver is presented. This is the PAL-S decoder.

To start the description of the decoder, I had better explain the reason for choosing a PAL-S decoder in the first place. This has not been done lightly.

Phase errors between the burst and chroma information can occur during transmission. The NTSC system provides no immunity against these distrurbances. If the decoder was of the NTSC type, phase displacements would cause the overall picture hue to be shifted, e.g. face tones would shift from pink toward green or blue. However, in the PAL system the phase of the (R-Y) colour difference signal is reversed on every alternate line. Therefore, in the case of a given subcarrier relative phase shift, the NTSC line ((R-Y) unreversed) will exhibit a given colour error. However, on the PAL line ((R-Y) reversed), the colour errors will be reversed. Since the video information is generally similar from line to line, the errors may be largely cancelled out by algebraically adding the two alternate lines, and displaying the result. This will occur optically in a receiver where no deliberate attempt is made to perform the adding task electronically. For small to medium phase errors the performance of such a receiver is acceptable, but large errors produce a patterning, known as the 'Hanover blind' effect. A decoder using this technique is known as a 'SIMPLE PAL' or 'PAL-S' type.

The errors may also be averaged electronically before display by passing each line through an ultrasonic glass delay line with a delay time equal to exactly one line period. Therefore, the line will emerge 64us late, just in time to be added to the next line. This type of decoder is known as a 'DE-LUXE PAL or PAL-D type, and is the type most often used in commercial colour receivers because of its improved performance.

The inclusion of a delay line confers another advantage, also. This is that the (B-Y) and (R-Y) sidebands are separated by addition and subtraction processes associated with the delay line. In a PAL-S decoder, this task must be performed by the synchronous demodulators alone. However, this is no problem if the demodulators are correctly designed.

The decoder being described is of the PAL-S type, because the degree of performance obtainable is quite reasonable in medium to strong signal strength reception areas, and it is felt that the extra cost and (at present) supply problems involving the 64us delay line would not be warranted.

I have compared the decoder with a PAL-D type in practice, over an extended period, and the PAL-S circuit has performed remarkably well. It will cope with a surprising amount of error before Hanover patterning becomes prominent.

As far as the basic signal paths are concerned, the decoder is conventional. However, the techniques employed to perform the various circuit functions are somewhat unusual, in particular the ident recovery and PAL switch. A basic knowledge of the PAL decoding process is assumed, because due to lack of space, a discussion of these techniques would be outside the scope of this article. A recommended textbook on the subject is 'Colour Television Theory', by Geoffrey H. Hutson (McGraw-Hill). (See also page 79.)

In this decoder, certain liberties have been taken with the chrominance bandwidth in the interests of economy. However, the subjective result as viewed on a colour CRT is quite acceptable. Circuitry has been further simplified by the deletion of automatic chrominance level control (ACC) and colour killing functions. The type of IF unit used minimises the effects of tuning drifts and thus does away with the need for ACC. When a black and white program is being received, the 'saturation' control should be turned fully anticlockwise. This will remove all spurious signals from the input to the synchronous demodulators.

A detailed description of the operation of the decoder circuit now follows.

LINE BUFFER

A composite video and chroma signal enters the decoder via C1. Since the input impedance of the chroma separation amplifier is low, the emitter follower Q1 is necessary to buffer the line from loading effects. Operating bias for Q1 is supplied by R1 and R2, and the low value emitter resistor R3 assures a fast pulldown time. Composite video and chroma is applied to the variable attenuator RV1-R4 via C2.

CHROMA SEPARATION

The DC coupled amplifier pair Q2-Q3 is biased into operation by R5 and R6. The bypass capacitor C5 ensures that the bias feed side of the parallel resonant circuit L1-(C3+C4) is maintained at ground potential as far as the chroma frequencies are concerned.

L1 is tuned to the centre frequency of the chroma bandpass response curve, 4.43 MHz. Composite video is injected into the resonant circuit via the common impedance R4, which is in series with a portion of the tuning capacitance C3. The amount of signal injected is controlled by the resistance ratio of the attenuator RV1-R4, and hence the setting of RV1 (the 'CHROMA GAIN' control). Since the tuned circuit is parallel resonant, a maximum potential appears across it (and hence at the input of the amplifier) at the centre of the band of chroma frequencies (4.43 MHz). The operating Q of the tuned circuit (and hence the bandwidth of the separated chroma frequencies) is controlled by the effective parallel resistance introduced by R4, the parallel resistance R5, and to a lesser extent by the amplifier's input impedance at the base of Q2.

Coupling from the collector load of Q2 (R8) to the base of Q3 is via the parallel resonant circuit L2-C7. Since this circuit is tuned to 5.5 MHz, it will exhibit a high impedance at this point and so pass all signals except those in the vicinity of the sound intercarrier frequency and its sidebands. In this manner, any 5.5 MHz component not removed in the receiver section is

prevented from being passed to the synchronous demodulators. This is essential, in order to avoid the generation of a nominal 1070 kHz beat between the chroma sidebands and the sound intercarrier frequency. Of course, the 5.5 MHz signal will already be attenuated by the chroma bandpass tuned circuit, but this higher Q tuned circuit provides an additional measure of attenuation. Very little sound signal is needed to wreck things!

The gain provided by Q3 is unity, because the collector and emitter loads (R10 and R11) respectively) are equal. However, because of the circuit configuration the collector of Q3 may be shorted to earth via the collector-emitter conduction of Q4. This action will remove the signal from the collector, but the emitter signal (the chroma output) will be undisturbed, since Q3 is still functioning as an emitter follower. The chroma separation circuit is decoupled from the +12 V rail by the components R7 and C6.

BURST GATE

Q4 is maintained in a conducting state by forward base current supplied through RV2 and R12 in series. The line oscillator in the receiver unit produces a positive going, 5us wide +12V pulse coincident with the line sync pulse in the composite video waveform. The trailing edge of this pulse is differentiated via C8, which turns Q4 off for a few microseconds following the end of the line sync pulse. Thus, the only time that signal is permitted to appear at the collector of Q3 is during the colour reference burst interval. The amount of differentiation, and hence the Q4 'off' time is made variable by means of RV2 so that the gate may be adjusted to close after the burst has finished, thus prohibiting extraneous signals from entering the colour sync circuits.

COIL DETAILS

L1 (4.43 MHz) Former: ¼" ext. dia. Winding: 20T 26G B&S ECW.

L2 (5.5MHz) Former: ¼" ext. dia. Winding: 15T B&S ECW.

L3 (4.43 MHz) Former: ¼" ext. dia. Winding: 20T 26G B&S ECW.

All formers "Neosid" PC board mounting type: 2450 / 1 / 6W.

All slugs "Neosid" type 6 x 1 x 13 x 900 (13mm long).

CRYSTAL FILTER

Q5 is a DC coupled crystal driver amplifier, into which is fed the gated colour sync bursts. The operating bias for Q5 is actually determined by R5 and R6, but the low DC gain throughout the chain Q2-Q3-Q5 assures good stability. Because of changing DC conditions an additional decoupling resistor is not practicable at this point, but the supply rail track impedance is decoupled by C9. The crystal Y1 is tuned to resonance at 4.433619 MHz by the trimmer CV1. At this point, its operating Q is very high, and bandwidth very narrow. Consequently, after excitaton by one burst, the crystal will continue to oscillate until the next burst, 64us later. The Q is so high that there is almost no variation in the ringing amplitude from the end of one burst to the beginning of another.

In order to identify the phase reversed line, the PAL colour reference burst swings -45° and —45° from nominal subcarrier phase on alternate lines. The Q of the crystal is such that it is unable to follow these phase alternations, and so the ringing oscillation takes up a phase relationship equal to the mean of the swings, i.e., 0° or subcarrier phase. However, during the burst intervals, large amplitude components at +45° and —45° (i.e. burst phase) are added to the output ringing waveform from the collector of the crystal driver amplifier, Q5. Thus, during the line periods the output from the crystal is at subcarrier phase, and during the burst intervals the output is at burst phase.

FET SOURCE FOLLOWER

In order to maintain a maximum operating Q from the crystal, a FET source follower (Q6) is used as an impedance converter between the crystal and the subcarrier oscillator. A decoupled voltage divider between the +12 V rail and earth (R15, R16 and C12) provides operating bias for the FET's gate, which is fed via R17. This resistor determines the buffer stage's input resistance. C10 is employed to couple the 4.43 MHz signals present across the crystal into the gate of the source follower. The source load resistor is R18, across which the buffered crystal signal is developed. The supply rail track impedance at this point is bypassed by C11.

SUBCARRIER OSCILLATOR

Q7 is a common emitter amplifier stage, in which the base bias resistors are R21 and R22. The bypass capacitor C17 ensures that the bias feed side of the parallel resonant circuit L3-(C15+VA1) is maintained at ground potential for the operating frequency of the oscillator. L3 is tuned to the subcarrier frequency, 4.43 MHz. The collector of Q7 is directly coupled to the unity gain dual phase output stage, Q8. A phase reversed version of the signal present across the collector load of Q7 (R24) is therefore available across the collector load of Q8 (R28). A portion of this signal is coupled back to the base of Q7 via RV4, R26 and the DC blocking capacitor, C18. Since L3-(C15+VA1) is a parallel resonant circuit, it will present a low impedance (hence shunting out the feedback path) to all frequencies other than the one to which it is tuned. The feedback signal is in-phase with the base signal, and oscillation will therefore occur at the frequency for which the input tuned circuit exhibits its maximum impedance, i.e. its resonant frequency. The amplitude of oscillation may be controlled by varying the resistance of the feedback path. RV4 performs this function, whilst R26 sets a maximum limit to the value of feedback.

The oscillator is injection locked to the output from the crystal filter, via the small capacitor C13. The free-run oscillator frequency is set in a coarse manner by adjusting the tuning slug in L3, and in a fine manner by means of the varactor diode, VA1. C16 is a DC blocking capacitor, and serves to isolate the bias voltage from the base bias voltage of Q7. The DC bias voltage for VA1 is picked off the wiper of RV3 (the 'colour lock' control), and applied via R20 to the cathode of VA1. A convenient range of frequency adjustment is determined by the value of R19, whilst the DC output from the wiper of RV3 is decoupled by C14.

The oscillator is decoupled from the supply line by R23 and C19. The emitter of Q8 conveniently provides an isolated point from which the oscillator output may be taken.

SUBCARRIER BUFFER

Q9 is an emitter follower stage which is used to provide additional buffering from the output of the subcarrier oscillator. Operating bias is supplied by R29 and R31, which feeds the base via the parasitic suppression resistor R30. Subcarrier signal is coupled from the emitter of Q8 to the base of Q9 via C20. The emitter load of Q9 is divided into R33, R34, R35 and R36 so that the correct signal levels may be distributed to the ident recovery, (B-Y) synchronous demodulator and (R-Y) 90 shift circuits respectively. The entire buffer stage is decoupled from the supply rail via R32 and C21.

It may appear that a self-maintained L-C oscillator would not possess adequate stability, but when used in this application stability is not a prime requirement because it is being locked by a continuous and phase-accurate frequency from the crystal filter. The function of the oscillator is twofold. The first requirement is that it provide a constant amplitude signal during the active picture periods for feeding the synchronous demodulators. The second function of the oscillator (ident recovery) is quite subtle.

IDENT RECOVERY

Although the oscillator is supplied with a constant-phase frequency for most of the time, the phase of the injected frequency swings between +45° and —45° during the alternate line burst periods (see section on the crystal filter).

The nominal operating frequency of the oscillator is set as near as possible to the subcarrier frequency, and the phase is reset to 0° during each line period, so when the +45° and —45° phase alternations arrive, the oscillator, because of its high operating Q and small injection amplitude continues to operate at or near 0° phase for a limited period. Thus two signals of differing phase are present in the oscillator circuit, which behaves as its own synchronous demodulator and so produces a positive or negative going pulse, depending on the phase of the burst relative to that of the subcarrier. Since this action is common to that of the generation of oscillations the two are superimposed and the end result is that the amplitude of oscillation is alternatively augmented or depressed during the burst periods. It is a relatively simple matter to extract a train of positive (or negative) ident correction pulses from this envelope.

Because the DC potential at the emitter of Q9 is higher than the DC base potential (i.e., earth) of the emitter follower Q10, diode D1 is reverse biased, thus keeping the base-emitter junction of Q10 "off". However the shunt capacity possessed by D1 couples the 4.43MHz pulse modulated subcarrier signal into the base of Q10. Since Q10 is not provided with any forward bias (R92 is a base return resistor), the input potential will have to exceed the cut-in voltage (0.6V) before it can appear at the emitter. The amplitude of the subcarrier signal present at the emitter of Q9 is 5V p-p, so after passing through the shunt capacity of D1 it will be symmetrically disposed about earth potential at the base of Q10.

Because signal can only appear at the emitter of Q10 when the input signal at the base exceeds +0.6V, rectification of the top of the envelope (the amplitude modulated area) takes place.

Colour TV decoder

The capacitor C22 removes the 4.43MHz carrier component by making the action of the emitter follower Q10 unsymmetrical. When the emitter is driven upward, considerable charging current is supplied to C22, which quickly sets itself to the peak voltage reached by the emitter. When the base voltage falls, the only way that C22 can discharge is via the emitter load resistor R38. This is very slow compared to the charging action, so the previous voltage sample is held until the next sample takes place. However the value of C22 is small enough to respond to the ident alternations, which are coupled to the base of Q11 via C24. The collector of Q10 is decoupled via R37 and C23.

The forward bias arrangements for Q11 are established in such a way that the base voltage due to the divider chain R39-R40 is slightly less than 0.6V, the cut-in voltage required by Q11. The negative ident swings coupled to the base of Q11 via C24 can only decrease this base-emitter voltage; but the positive swings add to the bias and saturate Q11, so resetting (if necessary) the ident flip-flop. C24 is specified as a polyester or polycarbonate type, to prevent the possibility of the standing bias on Q11 being disturbed by leakage.

Before going on to the next section, the behaviour of the subcarrier oscillator during the locking process will be described.

SUBCARRIER OSCILLATOR LOCKING CHARACTERISTICS

If the free run frequency of the oscillator is the same as the crystal frequency, the oscillator output phase will be coincident with the crystal phase. As the free run frequency is swung above and below that of the crystal, the two signals will remain locked in frequency, but the phase relationship will 'skew'. The amount and polarity of the error depends on the frequency displacement and whether the oscillator frequency is above or below the crystal frequency. When the frequency swings become too great, the oscillator will finally lose lock altogether. The correct operating frequency may be established by observing the modulated envelope at TP3. The colour lock control should be set at mid-travel. The slug of L3 is adjusted so that the beat frequency observed at TP3 gradually decreases to zero. The colour lock control can then be adjusted to produce equal amplitude alternate line burst modulations. Since the subcarrier oscillator is operating as a synchronous demodulator, this test shows that the burst swings must be equally disposed about the subcarrier frequency, and that the operating frequency and phase are therefore correct.

IDENT FLIP FLOP

Q12 and Q13 are connected to form a bistable multivibrator. The emitter of Q12 is earthed directly, but the emitter of Q13 is earthed via the base-emitter junction of Q14. Thus, as Q13 is turned 'on', Q14 is also turned 'on', and may drive its relatively low value collector load R43 without loading the master binary. The base return resistor for Q14 is R46. R41 and R45 are the binary collector loads, whilst the cross-coupling resistors are R44 and R47. C26 and C27 are speed-up capacitors.

The binary is clocked back and forth by line pulses from the line sync unit, supplied through C25. R42 is the rail return resistor, and D2 and D3 the steering diodes. A 7.8 kHz square wave (the PAL switch control voltage) is available from the collector of Q14.

The binary is reset to a predetermined state by the ident correction pulses when Q11 saturates. If the collector of Q12 is 'high', it is forced down to earth potential, thus depriving Q13 of base bias, and so turning Q13 'off'. As the collector voltage of Q13 rises, it forces Q12 'on', so reinforcing the action of the original correction pulse. If Q12 was in the correct state (i.e. 'on') originally, the binary state remains unaltered. Under these conditions, the collector waveform from Q14 will reverse the (R-Y) subcarrier signal on the correct line, and so produce a correctly coloured picture.

90 DEGREE (R-Y) SHIFT

The chroma information is transmitted as two suppressed carrier sidebands differing in phase by 90°. The (B-Y) signal has a phase relationship of 180° with respect to the subcarrier, and the (R-Y) signal has a phase relationship of 90° or 270°, depending on which line is being transmitted. Since the PAL switch provides a phase alternation of 180°, a further 90° shift is required is required between the output of the subcarrier oscillator and the input of the PAL switch.

This is provided by Q15, which is a split load dual phase stage. Operating bias is provided by R48 and R49, whilst subcarrier signal is coupled to the base of Q15 via C28. Antiphase signals are present across R50 (the collector load) and R51 (the emitter load), and the network C29-R52 connected between these points provides a 90° phase shifted signal for input to the PAL switch.

PAL SWITCH

Q16 and Q17 perform the task of reversing the subcarrier drive to the (R-Y) synchronous demodulator on alternate lines. Both stages operate as split load dual phase stages with voltage gains of unity. The collector load of Q16 is R55, and the emitter load of Q17 is R58 and R59 in parallel. The emitter load of Q16 (which supplies an in-phase signal) is R57, and is also the collector load of Q17 (which supplies an out-of-phase signal). Thus, if the bases of Q16 and Q17 are fed with a common AC signal and the amplitude is insufficient to cause the transistors to conduct when they are deprived of forward bias, a signal of either phase may be caused to appear across R57 by simply arranging for one transistor to be biased 'on', and the other transistor to be switched 'off', or vice-versa. Since Q16 is an NPN type, its base 'off' resistor is returned to earth, whereas the 'off' resistor for Q17 (a PNP type) is returned to the supply rail. The 'on' resistors for both bases are returned to a common point, which is the 7.8 kHz square wave output from the ident flip-flop. Thus, as this signal goes 'high' Q17 is deprived of bias, and Q16 is switched on, producing an in-phase signal across R57. When the square wave goes 'low', Q16 is deprived of bias and Q17 is switched on, producing an out-of-phase signal across R57.

In practice, so that an identical DC level may be achieved across R57 for both switch positions, the 'on' resistor for Q16 (R53) is made a fixed value, and the 'on' resistor for Q17 (R56 and RV4) is made variable about the value of R53. The subcarrier signal is

applied to the bases of Q16 and Q17 via the capacitors C30 and C33. The effective value of R58 is lowered slightly by the parallel resistor R59 in order to offset loading effects and so maintain equal AC channel gains.

Both (B-Y) and (R-Y) synchronous demodulators require a subcarrier signal drive of 2 V P-P. Since the PAL switch operates at a lower level than this, the amplifier stage Q18 is required. This stage lifts the switched subcarrier level to 2 V P-P, and also serves as an amplitude clipper to remove a negative-going transient which is generated in the switch through C30 and C33 when the two bases change bias levels.

The base return resistor for Q18 is R62. Forward bias is supplied via RV6 and R61, and in operation RV6 is adjusted to produce just sufficient operating bias to handle the switched subcarrier signal. When measured at the collector of Q18 (TP4), the peaks of the output sine wave signal will therefore just fall short of the rail voltage (+12 V). The transients (now positive going) are limited in amplitude to +12 V. In practice, to allow sufficient operating tolerance margins, the peak to peak value of the transients is adjusted to be 5pc of the peak to peak value of the signal. The supply rail impedance in the vicinity of the PAL switch and following amplifier is decoupled by C31.

SATURATION CONTROL BUFFER

This section carries on from the end of the description of the chroma separation stage. Q19 is a directly coupled emitter follower and is employed to buffer the collector load of Q3 (R10) from the input impedance of the chroma amplifier, Q20. The saturation (intensity of colours) control is conveniently arranged as the emitter load resistor, RV7. R65 is included in the collector supply lead to reduce dissipation in Q19 and also to minimise the possibility of parasitic oscillations being generated. The supply rail impedance for this stage is decoupled by C34.

FEEDBACK INVITED

Are you interested in seeing more articles on the broad subject of colour TV design and construction? If so, drop a line to the Editor and let him know, so that he can gauge the interest level in the subject. We won't be able to reply privately to your letters, but rest assured that they will be carefully noted as an expression of reader wishes. If the letters reveal sufficient interest, we will try to publish more articles similar to the present one and its sequel.

CHROMA AMPLIFIER

Q20 is a PNP linear amplifier stage with a voltage gain of 20 dB, and its purpose is to lift the chroma signal from the saturation control to a level which is sufficient to drive the synchronous demodulators. Under normal circumstances the stage has more than sufficient gain.

The emitter resistor for Q20 is R69, with the output being taken from the collector load, R70. The base bias resistors are R66 and R67, with chroma signal being coupled from the wiper of the saturation control (RV7) to the base of Q20 via C35. The chroma amplifier stage is decoupled from the supply rail via R68 and C36.

DEMODULATOR CHROMA BUFFERS

Since chroma information is applied to the emitters of the synchronous demodulators, independent buffering from the chroma amplifier is required for two reasons. The first is simply the need to avoid loading effects on the collector resistor (R70) in the chroma amplifier by the emitter input impedance of the demodulators. The second reason is due to the fact that the emitter drive chroma input configuration used in the demodulators also functions as an emitter follower, thus feeding the subcarrier signals present at the bases of the demodulators back into the chroma source. Since the chroma amplifier does not supply any other circuitry this would be of little consequence, but the problem with a common feed point for the demodulators is that the two subcarrier signals (180° shifted for (B-Y), and 90° shifted plus alternate line reversal for (R-Y)) would be fed into each other's demodulator, along with the chroma information. Because this would cause incorrect operation of both demodulators, a pair of emitter follower buffer stages is employed to isolate the two chroma inputs from each other.

The chroma buffer for the (B-Y) synchronous demodulator is Q21, which derives its operating bias and chroma signal from the collector of Q20 by being directly coupled to it via the parasitic suppression resistor, R71. The output signal is developed across the emitter load resistor R73, and the collector is decoupled from the supply rail via R72 and C37.

The chroma buffer for the (R-Y) synchronous demodulator is Q24, which is also fed from the collector of Q20, and operates in exactly the same manner as Q21.

(continued overleaf)

SUBCARRIER DRIVE BUFFERS

Because of inter-electrode capacities existing within the synchronous demodulator transistors, a proportion of the chroma signal applied to the emitter circuits finds its way on to the bases, and so back into the subcarrier source. For this reason it is necessary to include buffers between the subcarrier source and the bases of the demodulators.

In the case of the (B-Y) path, this buffer is Q22, which takes the form of an emitter follower. The base of Q22 is supplied with operating bias developed from the divider chain R74 and R75 and fed via the parasitic suppression resistor R76. Subcarrier signal is fed to the base via the capacitor C38. The output signal is developed across the emitter load resistor R78, and the collector and bias supply divider chain is decoupled from the supply rail via the components R77 and C39.

In the case of the (R-Y) path, the amplifier clipper stage Q18 serves as a buffering element.

SYNCHRONOUS DEMODULATORS

These devices operate on a gating principle, i.e., an amplifier with the chroma signal on one input, which is gated 'on' by the subcarrier drive applied to another input. In this case, the chroma signal is 'sampled' during the positive half-cycles of the subcarrier signal.

The (B-Y) synchronous demodulator is Q23, the circuit configuration of which is a unity gain amplifier with equal collector and emitter loads. The bias conditions as established by R79 and R80 are such that Q23 is just beginning to conduct (i.e. its collector voltage is slightly lower than +12 V.) The 2 V P-P 4.43 MHz subcarrier sine wave is added to the base bias voltage via C40. On the negative cycles of subcarrier signal, the standing bias voltage is opposed, and the amplifier cuts off. On the positive cycles, the standing bias voltage is increased, and the amplifier is driven further on, allowing the chroma signal (applied to the emitter via C41) to appear at the collector. The signal at the collector is therefore a series of samples of chroma information, with the sampling time being determined by the subcarrier waveform.

Before the low bandwidth (B-Y) colour difference signal can be used, it is necessary to remove the 4.43 MHz switching component from the recovered signal. The asymmetrical nature of current drive in the collector load of Q23 (R81) is made use of, together with C42, to reduce the 4.43 MHz component by integration without unduly sacrificing bandwidth. When Q23 is driven 'on', its collector voltage falls and the potential across C42 is forced down. However, when Q23 is driven 'off', the potential on C42 can only be raised by means of charging current supplied via R81. Thus, some of the potential is retained by C42 until it is 'reset' by the next 'on' sample. The remaining switching component is removed by the R-C low pass filter R83-C43. The coupling capacitor C44 is used to block the DC component of Q24's collector voltage from the following circuitry in the RGB output unit.

Since the burst is not removed from the chroma signal, demodulation products will appear on the back porches of the recovered colour difference signals. This will not introduce clamping problems because the video amplifiers use simple sync tip DC restorers. The demodulated signal will not be displayed because the picture tube will be blanked for the entire horizontal blanking period.

The (R-Y) synchronous demodulator is Q25, which operates in exactly the same manner as Q23, except that in this case the 90° shifted and switched subcarrier is supplied to the base circuit from the collector of Q18 via C46.

The main +12 V rail bypass capacitors for the PC cards are C51 and C53, with the parallel high-K capacitors C52 and C54 ensuring that by-passing is maintained at high frequencies where the inductive effects of electrolytics may tend to become troublesome. All other bypass capacitors are either 100n high-K types, or 10u tantalum 'tag' electrolytics which have good high frequency characteristics, anyway.

LINE SYNC ARRANGEMENTS

At present, the planned receiver has a double line sync system. This consists of a triggered line oscillator (to achieve timing accuracy) followed by a phase-locked loop (to achieve noise immunity). The burst gate is fed from the triggered oscillator, and the ident flip-flop is clocked by pulses from the PLL. This arrangement enables accurate burst gate timing, together with freedom from false triggering of the PAL switch by noise pulses.

OVERALL CIRCUIT DEVELOPMENT

The normal procedure for developing new equipment is first to design the circuit that we hope will perform the function required. The next step is to make a rough 'mock-up' of the circuit and check its actual operation against its calculated performance. A circuit may not do all that is hoped for it, and modifications may be necessary. Quite often, a particular circuit section may be unsatisfactory for one reason or another, thus necessitating a re-design of that particular portion. Then there are component tolerance and temperature tests, etc.

My usual technique for building prototypes is to string the components together between tagstrips, which are in turn soldered to a conducting base such as a sheet of un-etched PC card. This forms a convenient earth plane, and the overall structure bears the very apt title of a 'rat's nest'. However, it has the advantage of having no fixed form, so that drastic changes to the circuitry may be implemented with little effort. Once the circuit is performing reliably in this state, a PC card must be prepared. However, if the circuit is to be capable of easy reproduction readily available components must be chosen for the PC card. The characteristics of these components may vary slightly from those used in the lab. prototype, and also trouble may be experienced with track layout and track impedances, especially in the VHF spectrum. And there are the inevitable errors in track placement and component mounting centres, so that several issues may be necesssary before the board is completely satisfactory.

The circuits presented in this article have been taken to the 'rat's nest' stage, and in that form they were completely satisfactory. PCC layouts have also been prepared, but component shortages have slowed up the testing programe. For this reason, the constructional details have been held over for inclusion in part 2. For the reasons outlined previously the final circuit may differ slightly from that presented here. If changes are necessary, they will be fully documented.

CONSTRUCTION

The decoder is contained on two single sided PC cards. The chroma separation, burst gate and subcarrier generation circuits are on one card, and the ident recovery, PAL switch and synchronous demodulators are on the other. For the sake of convenience, the former will be referred to as the SUBCARRIER card, and the latter as the DEMODULATOR card. All components are readily available, with the exception of the crystal which may be ordered from such firms as Bright Star Crystals Pty Ltd and Hy-Q Electronics Pty Ltd.

In a typical domestic receiver situation, the only front panel adjustment would be the saturation control. The colour lock control would be a 'back-of-cabinet' type, and the remaining pots would be on the PC cards, which are drilled to take either preset tab potentiometers or wires.

ALIGNMENT

Since the decoder would normally be operated with its associated RGB output unit, the alignment procedure for both sections will be included in part 2, after the RGB output unit has been described. The only instruments required are a CRO with a known response at 4.43 MHz, and a source of colour video signals. This should ideally be a colour bar or rainbow generator, although ordinary program material can be used because both the decoder's 90° (R-Y) phase shift and the RGB output unit's (G-Y) matrix proportions are determined by circuit constants.

(To be continued)

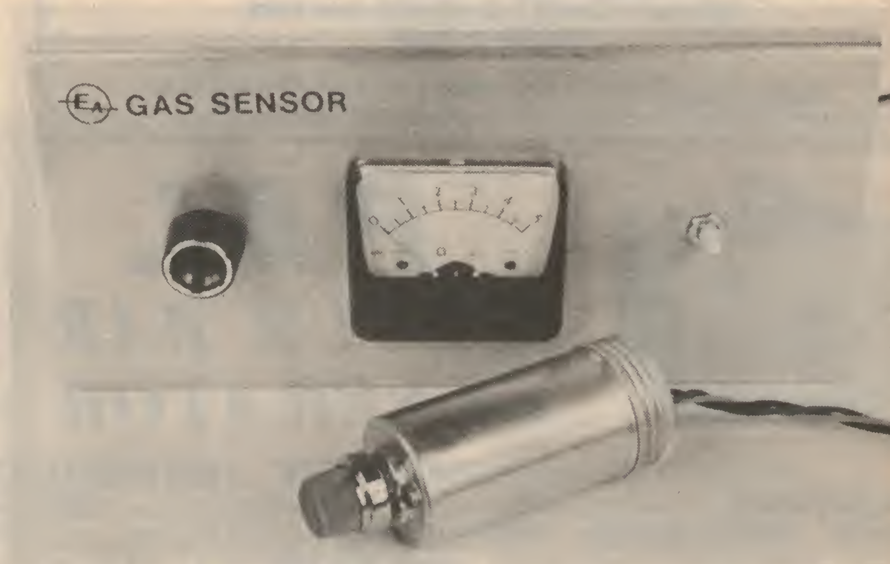
Is your air clean? Is your gas leaking?

An electronic Gas Detector

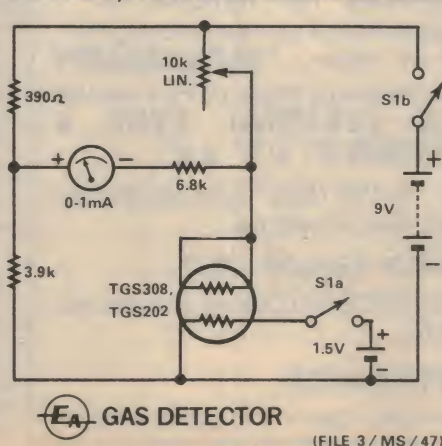
by LEO SIMPSON

The human nose is probably still the best gas detector we have, yet there are many applications where an electronic gas detector would be very handy. Now, for the first time, there is available a semiconductor gas sensor which enables us to present this electronic gas detector.

The number of applications for gas sensors must be almost as long as the list of gases. But some of the more important applications are as an automotive exhaust analyser, petrol vapour detector for boats, gas leak detector, carbon monoxide detector, air pollution meter, paint dryness



Above is the prototype Gas Detector with the TGS (Taguchi Gas Sensor) mounted in an aluminium pill can. Below is the circuit which is very simple to build.



indicator and even as a breathalyser!

Of the above applications, perhaps the exhaust analyser and petrol fume detector for boats are the most often requested projects from our readers. But whatever the application, it has only recently become possible to design any circuitry to do the job.

Previously, exhaust gas analysers and other gas detecting instruments used the heat generation from catalytic reaction on a hot wire (platinum). However, these types of instrument are very expensive and have short life expectancy.

Our instrument is designed around a new type of semiconductor device known as a Taguchi Gas Sensor (TGS) developed by Mr N. Taguchi of Japan and marketed by Figaro Engineering Inc of Japan. The TGS responds to certain gases, vapours and smoke particles. While it cannot distinguish between different gases it can record the relative concentration of a contaminating gas in air.

The TGS is a sintered n-type semiconductor device which is composed mainly of tin dioxide. Its conductivity varies widely when it comes into contact with a combustible gas such as hydrogen, methane, ethane, propane, alcohols, petrol, carbon monoxide and so on.

Embedded in the semiconductor chip are two heating coils made of an alloy of iridium and palladium and with a resistance of approximately 2 ohms. Only one filament is used to heat the chip, while the other is used merely to make electrical contact to the chip.

When a gas such as propane is adsorbed by the surface of the chip, the chip resistance is reduced accordingly. The heat from the filament is required to convect the contaminant through the sintered porous structure of the chip and to drive the gas off (de-adsorb) when the source of contamination is removed.

Resistance change in the presence of a contaminating gas can be very marked. In clean air, the chip resistance may be anywhere from 10k to 50k but it will fall to less than a twentieth of this value when the concentration of propane in air is as little as 1000 parts per million. Similar changes occur for the other gases we have listed.

Refer now to the circuit. It is merely a simple bridge with the TGS forming one resistance leg. Normally, the bridge is balanced with the aid of the 10k potentiometer so that the meter indicates zero. When the chip resistance drops due to the presence of a contaminating gas, the meter indicates accordingly.

Our circuit uses batteries but the chip is not polarised so it can be connected either way around and the filament can be heated by AC. The heater consumes between 600 and 800 milliamps at 1.2 to 1.5 volts.

When the circuit is first turned on the meter pointer will move well up scale and then fall slowly back. This is because the sensor adsorbs contaminating gases in the air while it is not in use and these must be

driven off by the heater before the chip resistance rises to its normal "clean air" value.

The time taken for the contaminating gases to be driven off, or the effective "warm-up" time, varies according to the TGS type.

For detecting combustible gases such as coal gases, petrol vapour, alcohol and other hydrocarbon gases, type 308 is used. This has a fast warmup time and is ready for use in two minutes or less.

Type 202 will detect all the above gases plus carbon monoxide and smoke, but it has a long warm-up time of five minutes or more, depending on the length of time since it was last used.

Either TGS type may be used in the circuit described here without modification. It is possible to shorten the warm-up time of the type 202 by switching both its heaters in parallel at initial switch-on.

TGS units are distributed in Australia by the component division of Tecnico Electronics and by Mode Electronics Company, PO Box 365, Mascot, 2020. Mode Electronics supplied samples for the preparation of this article. We assume that all major kit suppliers will have stocks of TGS units in due course but in the meantime they can be supplied by Mode Electronics Company. Refer to page 122 in this issue for their advertisement.

PARTS LIST

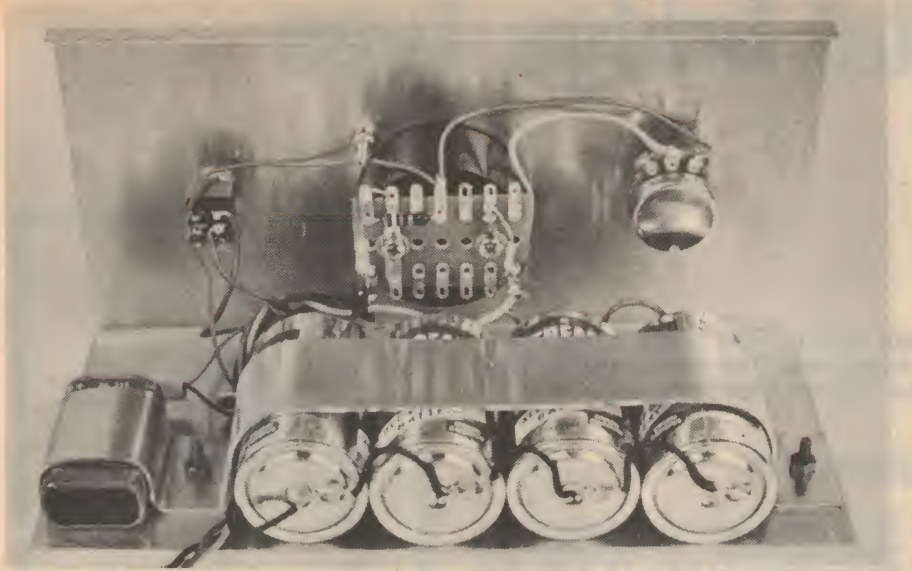
1 chassis (see text)
1 meter movement, 500uA or 1mA sensitivity
1 Eveready 216 9V battery plus connector
4 Eveready 950 "D" 1.5V cells
1 seven lug length of miniature tagboard
1 DPST toggle switch
1 Figaro TGS 202 or 308 gas sensor
1 seven-pin valve socket
1 x 390 ohm, 1 x 3.9k, 1 x 8.2k, ½W or ¼W resistors
1 battery clamp (see text)
1 metal pill case (see text)
1 grommet

MISCELLANEOUS
hook-up wire, screws, nuts, washers, solder, Letraset.

There are quite a few approaches that can be taken when building our gas sensor. We have taken a very simple approach in building the prototype. If reader interest is sufficient we may present a more complex circuit capable of more critical use.

As shown in the photographs, the prototype is built on a simple L-shaped aluminium chassis 205mm wide, 100mm high and 100mm deep. Battery power is used. For the 9V source we used an Eveready 216 battery. For the 1.5V source, bearing in mind the considerable current required, we used four Eveready 950 "D" size cells wired in parallel.

There seems little point in using more expensive cells or even a single large 1.5V cell. The 950 is well suited to continuous heavy discharge and is relatively cheap. Since we could not obtain a suitable battery holder at the time of writing we simply soldered the cells directly in parallel with hook-up wire. A clamp for five batteries was made from a length of aluminium bent to



Rear view of the Gas Analyser showing how the batteries are mounted.

shape with the aid of a vyce and an old battery as a former.

A small 1 milliamp movement serves as the meter. Other meters can be pressed into service if they are on hand. For example, a 500uA movement can be used if the 6.8k resistor is increased to 12k. We have not bothered to calibrate the meter, as a known gas mixture is required if the calibrations are to mean anything. But this could certainly be done if you have the facilities.

A 10k potentiometer is used to zero the meter in a "clean" air mixture. While we mounted the potentiometer on the front panel, there is no reason why a small preset pot cannot be used. Once the pot is initially adjusted to suit the sensor there should be little need to adjust it apart from a "tweak" every now and again.

Since there are two voltage sources in the circuit, a double-pole switch must be used. In the prototype, we used a miniature toggle switch wired for double-pole, single-throw operation. Since these small switches have a current rating of several amps, there is no problem in this regard.

For convenience, the three resistors in the circuit are mounted on a length of miniature tagboard on the back of the meter movement. The mounting holes of the tagboard were enlarged slightly to allow the board to be mounted on the back of the meter.

While we have made the prototype self-contained with its own batteries, it can be powered externally. For example, it can be run from a 12V boat or car battery. In this mode, the bridge circuit may be run directly from 12V while the heater filament is powered via a 22ohm 10watt resistor.

Alternatively, the circuit can be powered from the 240V AC mains via a 6.3V transformer. The heater filament can be run directly from the 6.3VAC via an 8.2ohm 5 watt resistor. At the same time, the 6.3VAC can be half-wave rectified by a single diode and then filtered with a 470uF⅞12VW electrolytic capacitor to provide 9 volts DC for the bridge circuit.

The TGA sensor for the prototype was mounted on the end of a suitably long cable. This enables it to be mounted remotely to the meter so that it can monitor the bilges of a boat, exhaust gases, poisonous gases and so on. It can safely monitor explosive gas mixtures, since the double 100-mesh gauze covering the chip is proof against explosions.

Spacing of the four pins of the TGS sensor enable it to fit neatly into a seven-pin valve socket, which is what we used. It can be supplied with a special four-pin socket but this is only suitable for mounting on a printed circuit board. We mounted the seven-pin valve socket and sensor on the end of an aluminium pill container.

The three wires from the socket run through a grommet in the lid of the pill container. The wires are twisted together to form a neat cable. At the chassis end they are firmly secured with the aid of the battery clamp.

Around the home, the prototype Gas Detector could have a variety of worthwhile applications. For example, it will respond very rapidly if a gas stove is turned on without lighting it — useful in a home where small children often turn on the gas taps. In this sort of application the Gas Detector would have to be mains powered to give round-the-clock monitoring.

A prime use for the Gas Detector would be as a petrol fume detector on a boat. The sensor can be mounted remotely in the bilge while the meter is mounted on the instrument panel. A routine would have to be followed though — always turn on the detector (using type 308) a few minutes before starting the engine. But it would be foolish to rely absolutely on this device as a defence against explosions — the bilge should be kept well ventilated.

The Gas Detector can also be a useful aid in setting the idling mixture of an automobile, although remember that it gives comparative results only. And the engine must be warmed up properly before the mixture can be adjusted.

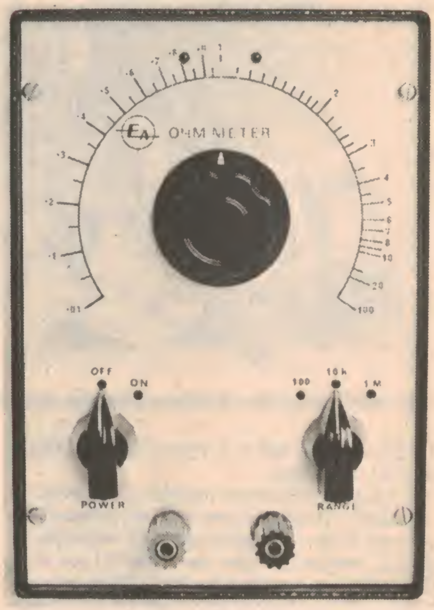
At a party, the Gas Detector can be used as a novelty breathalyser. It gives a strong indication if a person has been consuming alcohol, even odourless drinks like vodka. It can give a false indication, though, when a person breathes hotly into the sensor as this raises the sensor temperature slightly which gives a slight change in its resistance.

At the same time, we do not suggest that you have a drink just to test out the Gas Detector.

Experimental bridge type ohmmeter

Here is an interesting experimental project which should appeal to beginners and advanced workers alike; a simple bridge type ohmmeter using a novel form of null indicator. The circuit would also lend itself to a wide range of other applications.

by DAVID EDWARDS



The front panel of the bridge, prepared on a piece of card. Calibration points are calculated as explained in the text.

Following the description of our most recent RC Bridge (March 1974) there was some discussion in our laboratory concerning bridge circuits in general and the manner in which they can be modified to perform specific functions. The discussion considered in particular the various forms of null indicator available and their suitability for unskilled operators who, ideally, need an unambiguous "high" or "low" indication or, in some cases a simple "go" or "no go" indication.

Arising out of this was the circuit we are about to describe; a null indicator based on an operational amplifier IC (uA741) and a pair of light emitting diodes. Not only is it a novel circuit but, as far as we know, also an original one. More importantly, it would seem to have considerable potential in many applications, particularly those involving unskilled operators, as already mentioned.

Fig. 1 is a simplified explanatory circuit, in which the operational amplifier is being used as a comparator. If the voltage at the non-inverting input is higher than that at the inverting input, the op amp will saturate, and the output voltage will rise to a value close to that of the positive supply rail, Vcc. This will forward bias one of the light emitting diodes, which will give a visible indication, and reverse bias the other diode, which will not emit.

When this situation is reversed, and the voltage at the inverting input is higher than that at the non-inverting input, the op amp will saturate in the reverse direction, and the output voltage will fall to a value close to that of the negative supply rail, — Vcc. This will forward bias the other light emitting diode, and reverse bias the first one.

Since the op amp has a very high gain, the change-over between the two conditions will occcur very rapidly and over a very small range of differential input voltages. Thus the null of the bridge will be indicated by the point at which the two LED's change from off to on and vice-versa.

To prove the circuit, we made up a simple bridge network similar to that shown on the left hand side of Fig. 1. It is, in fact, a perfectly standard arrangement such as used in the March, and earlier, bridges.

It consists of a 1k linear pot, a set of three standard (close tolerance) resistors, a battery, and provision to connect the unknown resistor (Rx). The 1k pot forms a pair of resistors whose ratio is variable over a wide range although, in practice, we limit this range so as to provide a practical scale. From the mid position of the moving arm, which represents a 1 to 1 ratio, we provide for an extremity of 100 to 1 in either direction.

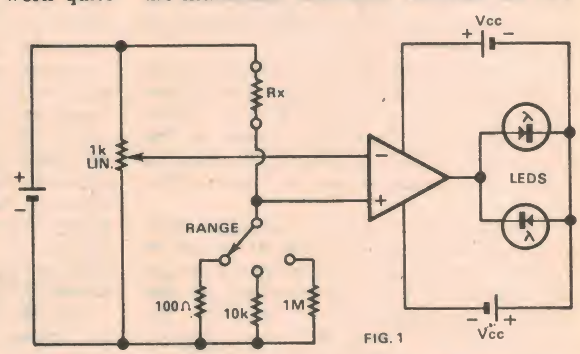
The three standard resistors are 100 ohms, 10k and 1M. In conjunction with the pot movement just discussed, this gives a range of measurement from at least 10 ohms to 10M, beyond this with some limitations, and with useful overlap between ranges.

After ironing out a few minor problems we came up with a circuit which we feel is worth passing on to readers. As presented it is a simple battery operated bridge, using relatively few low cost components, but capable of quite useful accuracy. It would seem to be an ideal project for YRCS groups or similar organisations.

Alternatively, by using closer tolerance components, it can be upgraded to provide a much higher order of accuracy, but at some increase in cost. And for the really keen experimental types there is an almost unlimited scope for its exploitation in automatic control circuits.

The practical circuit is shown in Fig. 2, and is worth discussing in some detail. The 741 op amp requires nominal voltages of plus and minus 15, but it will work quite satisfactorily for our purpose from voltages as low as plus and minus six. Since 9V batteries are readily available in convenient sizes, we elected to use two of these.

Fig. 1. Simplified diagram showing the basic bridge configuration. Note that the 1k linear pot provides two of the four resistors making up the bridge. The other two are the unknown resistor and one of the standard resistors selected by the range switch.



This gives us a total of 18V, which also becomes the power supply for the bridge. The latter should be as high as possible when high value resistors are being measured, otherwise current due to thermal noise in the resistors may be comparable with the current due to the supply.

On the other hand, a high supply voltage causes problems when low values of resistance are being measured, as the battery drain increases enormously. To avoid this, limiting resistors are connected in series with the bridge. To keep the input voltages to the op amp centered about zero, equal value resistors are fitted at the top and bottom of the bridge.

These resistors also limit the current to the op amp inputs, so that it is not necessary to provide separate input resistors. A protective resistor is required for the LEDs, to keep the forward current within the maximum allowable. Because the two diodes ae back to back it is not possible to exceed their reverse voltage rating.

When the prototype was constructed, some trouble was experienced with oscillation at the null point. This took the form of cycling between the LEDs, which made both LEDs appear to be on at the same time. This was prevented by using a 1uF capacitor to provide negative feedback from the output to the inverting input.

In order to prevent oscillation if the wiper arm of the pot should become dirty and go open circuit, it is necessary that the wiper arm be connected to the inverting input, and not the non-inverting input.

The circuit does have one minor disadvantage. Because the null indicator operates from the same supply as the bridge, and because there will be some leakage between the op amp input terminals and the supply rails, there will be some error introduced into the null indication at higher resistance values. In practice this is insignificant up to about 10M, which should be regarded as the upper limit for accurate measurement.

The only close tolerance components are the three standard resistors. We used 1% types but, if these are not available, it may be possible to trim 5 or even 10% types to the correct values. To ensure stability with respect to temperature, only good quality components should be used.

We constructed our unit on a panel measuring 111mm x 161mm, which happened to suit a box we had on hand. Since the size of the panel and the type of box is not critical, we suggest that the reader make his own choice in this regard, possibly also using something which is on hand.

A good idea of the panel layout and general assembly can be obtained from the photographs. The pot is in the top centre of the panel and the two switches and the unknown resistor terminals at the bottom. The LEDs we used fit neatly into a ⅛in hole and we mounted them at the top of the panel, about 20mm apart, where they are easily seen.

The only other piece of metal work is a simple battery clamp made from a scrap of aluminium. It is roughly "U" shape, but with wings extending outwards from the uprights of the "U". One 9V cell is held under each of these wings, but they also support a piece of veroboard on which is mounted the IC and other minor components. The bracket and the veroboard are clearly visible in the photograph. The bracket is fastened to the front panel by the pot, avoiding the need for unsightly screws.

We mounted the three standard resistors on the back of the single pole three position range switch. It was necessary to add a dummy terminal to the switch, to provide the common point for the resistors, by attaching a solder lug to a spare hole fortunately provided. Alternatively, there is ample room to mount the resistors on the veroboard with the remainder of the components, although this will entail running more wires to the switch.

The 741IC we used was in a 14 pin dual-in-line package. These devices are also available in an 8 pin dual-in-line package and in an 8 lead metal can. All are suitable for use in the bridge. We used veroboard with the correct hole spacing to suit the dual-in-line package.

In order to reduce the height needed for the op amp, we mounted it directly on the veroboard. As only pins 4, 5, 6, 10 and 11 are used, we did not solder the remaining pins to the veroboard. This makes it easier to remove the op amp if necessary. Take care not to damage the IC while it is being soldered, due to excess heat. It is a good idea to leave it to the last to solder in.

As shown in the photographs, the IC and the remaining three resistors are mounted on top of the veroboard. The LED's and the 1uF capacitor are mounted underneath. This saves space, in the case of the capacitor, and enables the LED's to fit into their mounting holes in the front panel. The veroboard is attached to the battery mounting clamp using two self-tapping screws and some washers for spacers. Leave sufficient clearance under the board to avoid shorts to the battery case.

We chose to polarise the unknown resistor terminals by selecting one red and one black. While resistors are not normally polarised, the bridge may be used in other applications, such as checking the forward and reverse leakage of a diode. The red terminal should indicate positive.

We used pointer knobs for the two rotary switches and a larger round knob for the potentiometer. To this we added a clear plastic pointer, fastened to the bottom of the knob with a strong epoxy glue. Make sure that the line on the pointer is truly radial and in line with any lines or arrows already on the knob.

Finally, there is the matter of a scale. In the case of previous bridge projects we have been able to publish a calibrated scale and supply details to any firms wishing to supply etched labels. We are deliberately avoiding this approach on this occasion for a number of reasons.

Such a scale is valid only if the pot used by the builder is identical with that used in the prototype. This means, in practice, nothing

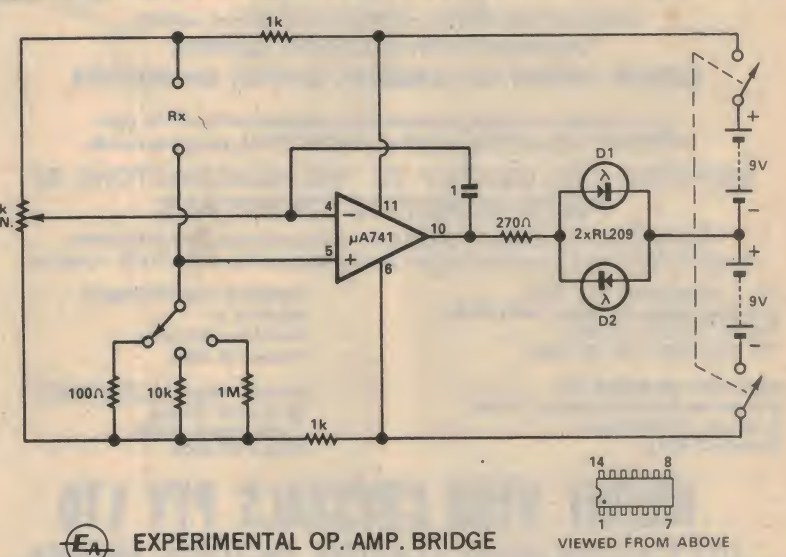


FIG. 2

Fig. 2. The circuit as finally developed. The bridge circuit remains essentially the same, except for the addition of two 1k current limiting resistors. The one battery pack, supplying 9V each side of a centre tap, serves both the bridge and the IC.

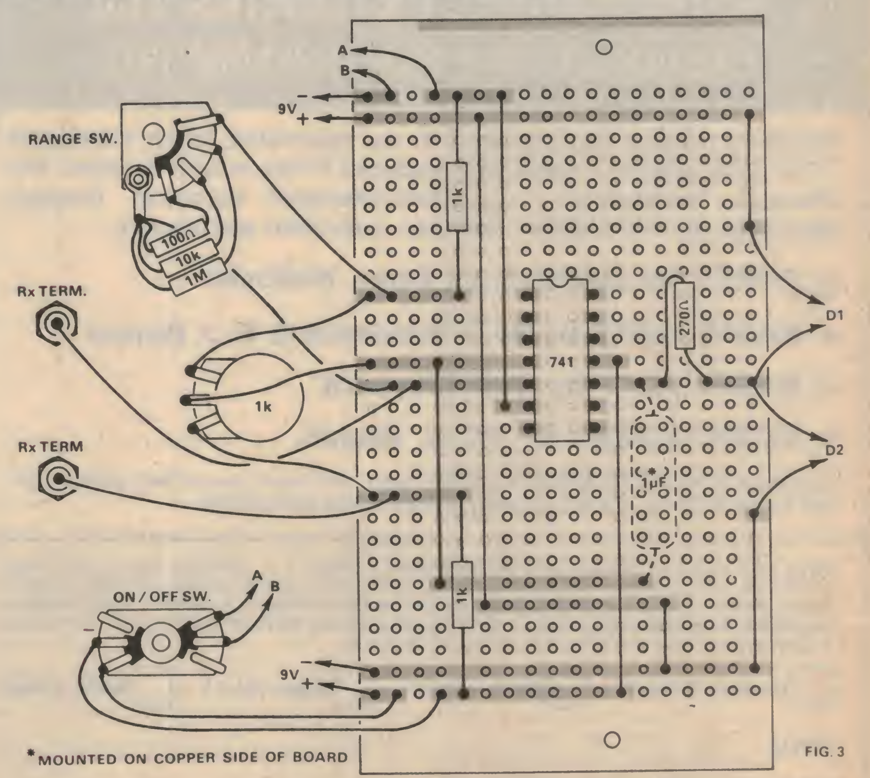


FIG. 3

Fig. 3. Wiring diagram showing the general layout of components and the pattern of the Veroboard. Layout is not critical and almost any other physical arrangement would be acceptable. All components mount on the panel, simplifying the choice of a box.

less than a wire wound type of the same make and model. Unfortunately, wire wound pots are quite expensive and, to keep the cost down in what is, after all, mainly an experimental project, we used a linear carbon pot, which is a good deal cheaper.

Unfortunately, carbon pots, as a class, introduce two unwanted variables. They are not necessarily as linear as the wire wound type, even from unit to unit of the same model, and the angle of rotation varies from make to make. Thus, a scale prepared for brand "A" will not necessarily suit brand "B".

The pot we used was a "Soanar" brand, No. 7222 and, if readers are able to obtain this same make and model they will at least have the same angle of rotation. But the linearity is another matter.

Because of these variables, the best approach is to make one's own scale; an interesting exercise in its own right. There are two approaches. One is direct calibration against a large number of close tolerance resistors, ideally one for each calibration mark.

The other is direct calibration of only two points, one at each extremity of the scale, and all other points by calculation on the assumption that the pot is linear.

PARTS LIST

1 uA741 op amp, or equivalent
1 red LED's, CEMA RL209 or similar
2 1k ¼ watt resistors
1 100 ohm 1% ¼ watt resistor
1 270 ohm, ¼ watt resistor
1 10k 1% ¼ watt resistor
1 1M 1% ¼ watt resistor
1 1k linear pot
1 1uF capacitor
2 9V batteries with clips, "Eveready" 216 or similar
2 terminals, 1 red, 1 black
1 2 pole 2 pos rotary switch, MSP No AK 19202 or similar
1 1 pole 3 pos rotary switch, MSP No AK 19207 or similar
3 knobs to suit (see text)
vero board, scrap aluminium, hookup wire, solder, self-tapping screws, white card, 5mm spacers, solder lugs, screws and nuts, small piece of clear plastic.

Note: resistor wattage ratings and capacitor voltage ratings are those used in our prototype. Components with higher ratings may generally be used provided they are physically compatible. Components with lower ratings may also be used in some cases, providing ratings are not exceeded.

Obviously the first would be the more accurate, but is seldom practical. The second is more practical, but leaves the accuracy at the mercy of the pot linearity. We used the second method.

For this method we require three close tolerance resistors, 1k, 10k and 100k, a protractor, and ordinary drawing instruments. The first job is to determine the angle between two selected values near the extremities of the pot rotation. Place a scrap of paper on the panel where the scale will finally fit and secure it with sticky tape. Fit the pointer so that it swings approximately evenly each side of centre.

This setting is not critical at this stage.

Set the range switch to 10k and note the positions at which the 1k and 100k resistors are nulled. The 1k should null near the furthest anti-clockwise position, and the 100k near the furthest clockwise position. If these positions are reversed, reverse the outside connections to the pot.

Remove the pointer and the piece of paper and, with the protractor, measure the angle between the two marked points. This will be easier if the centre of the pot can be marked, using lines at right angles, before the paper is removed from under the pointer. The angle should be about 200 degrees.

Let us call this angle W. Then, if s is the fraction or multiple of 1 by which the standard has to be multiplied, and p is the angle in degrees that actually corresponds to this value of s, we can say $p = 0.611 \times W \times (s - 1) / (s + 1)$. This formula enables the values of p to be calculated from the values of s. The angle p is measured from the vertical, which corresponds to the position $s = 1$, $p = 0$. The angles are measured positive clockwise and negative anti-clockwise.

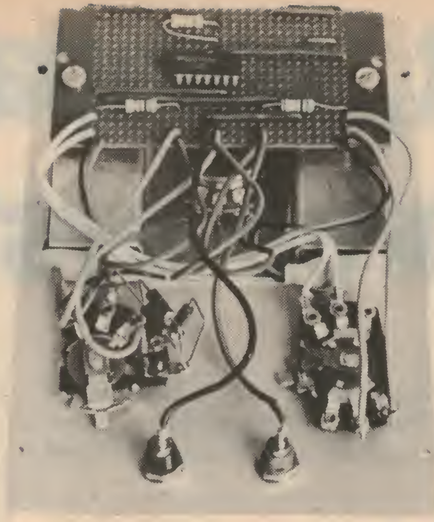
As an example, we have calculated the angle at which the scale marking "0.5" would be placed. We have taken the measured value W as 200.

$p = 0.611 \times 200 \times (0.5 - 1) / (0.5 + 1)$
$p = 122.2 \times (0.5 - 1) / (0.5 + 1)$
$p = 122.2 \times (-0.5) / (1.5)$
$p = 122.2 \times (-0.333)$
$p = -40.74$ degrees

This means that the scale point marked "0.5" should be positioned 40.74 degrees anti-clockwise from the centre of the scale.

These calculations will be much easier if a slide-rule or a calculator can be used, as well as being much less prone to error.

Once the values for the scale have been obtained, the scale can be drawn on a suitable piece of white card. We made the scale with a diameter of 80mm, the major graduations 6mm long, and the minor graduations 3mm long, using India ink. Black ball point pen would provide an acceptable substitute for ink. We used rub-on lettering to mark the major points on the scale, and also to label the functions of the rotary switches.



The bridge is built on the front panel. Note the bracket which serves as both a battery clamp and support for the wiring board.

When the scale is finished, suitable cutouts must be made for the pot and switch shafts, the LED's and the terminals. With the scale fitted, the pointer can be attached to the pot shaft, and correctly aligned with the scale. This is done using the 10k close tolerance resistor, with the range switch on the 10k range. The pointer should be attached to the shaft so that when the bridge is balanced, the pointer reads 1.0. Provided there are no serious linearity errors in the pot, the scale should then be accurately calibrated for all ranges.

Care should be exercised in regard to battery life. The current consumption is highest on the lowest resistance range, and unlike an ohm-meter, current is consumed even when the unknown terminals are open circuit. Fortunately, the LED's give a visible indication that the power has been left on. Otherwise, due to the intermittent nature of the current drain, battery life should be quite long.

Low cost, compact home stereo system

Here is a new low-cost stereo amplifier design, forming the basis of an economical, high quality stereo system. At the heart of the design is a new audio power IC from Texas Instruments, capable of delivering sufficient power for a compact domestic situation.

by DAVID EDWARDS

The completed prototype fitted to a BSR Model G11202 turntable is shown above, whilst the full circuit details are shown on the facing page.

When integrated circuits capable of delivering a reasonably high level of audio power output appeared on the scene about four years ago, they had an immediate appeal. Requiring only a handful of external components to form a complete amplifier, they were ideally suited for a wide range of utility audio applications.

In Australia one of the most widely used of these devices has been the Plessey type SL403D, and one of its most popular applications has been in low-cost stereo amplifiers designed to mount directly under a record player turntable in the wooden plinth. The last design of this type described in Electronics Australia was the Playmaster 137 design in March 1973, of which very large numbers have been built. With a power output of 3 watts RMS per channel and full bass and treble facilities, it can sound quite impressive when fed into reasonably sensitive loudspeakers.

Unfortunately like so many other projects published by ourselves and other magazines, the Playmaster 137 design has not remained untouched by the current parts supply difficulties. In particular, the Plessey SL403D device itself has become rather scarce, so that while the March 1973 design is still quite up-to-date, it is currently not a project which one can start upon with the confidence that it can be speedily completed and put into operation.

Realising that this was the case, we were interested to learn recently from Kitsets Australia Pty Ltd that they had been appointed distributors for Texas Instruments semiconductor devices, and that among the TI devices which they had to offer was a new audio power IC. This is the SN76023, a device in a modified 16-pin dual in-line plastic package fitted with a fan-shaped extruded heatsink.

Using two of these devices we have designed a small stereo amplifier, with full bass and treble controls, suitable for mounting either under a plinth or in a suitable cabinet. Almost all of the circuitry is contained on a single printed circuit board, which follows the same basic format as the board used in the Playmaster 137.

The version presented in this article is for plinth mounting. A version with the board mounted in a case is planned to appear in the near future, and will be of similar design to the Playmaster 137.

Unlike the 137, we have not combined the balance control with the on / off switch. Instead, we have repositioned the balance control near the volume control, as this gives a more logical layout of the printed circuit, and we have provided a separate toggle switch to provide the on / off function. This means that there is less chance of hum pickup, as the 240VAC wiring can be kept away from the input circuitry.

A 3-pole 3-position rotary switch is used to select the input to the amplifier. One position selects ceramic cartridge, another an auxiliary input, while the third gives provision for replay from a tape recorder or tape deck. This connection is made via a standard 5-pin DIN connection cord. Most modern tape recorders and tape decks have this facility. Provision has also been made to enable recordings to be made from either records or the auxiliary input.

This has been done by connecting the outputs of the amplifier to the tape DIN socket. Because of the configuration of the circuit used, it was not possible to take the signal from the usual point in the circuit, which is before the balance and tone controls. This is because the SN76023 is used in a configuration similar to that of an operational amplifier — with feedback, incorporating the bass and treble controls, applied from the output to the input directly.

As a result of this, we were forced to use the same signal as is fed to the speakers. This means that while any recording is taking place, the tone controls must be set at the flat positions, and all the controls left in the positions occupied at the beginning of recording. In particular, the volume control must not be altered during recordings. We have provided trimpots to attenuate the recording signal so that at normal listening levels, the signal level is suitable for the tape machine being used.

We have relied on the switching in the tape machine to reject the output signal of the amplifier during playback. This is a normal function of a tape machine, necessary in order to prevent oscillations from occurring.

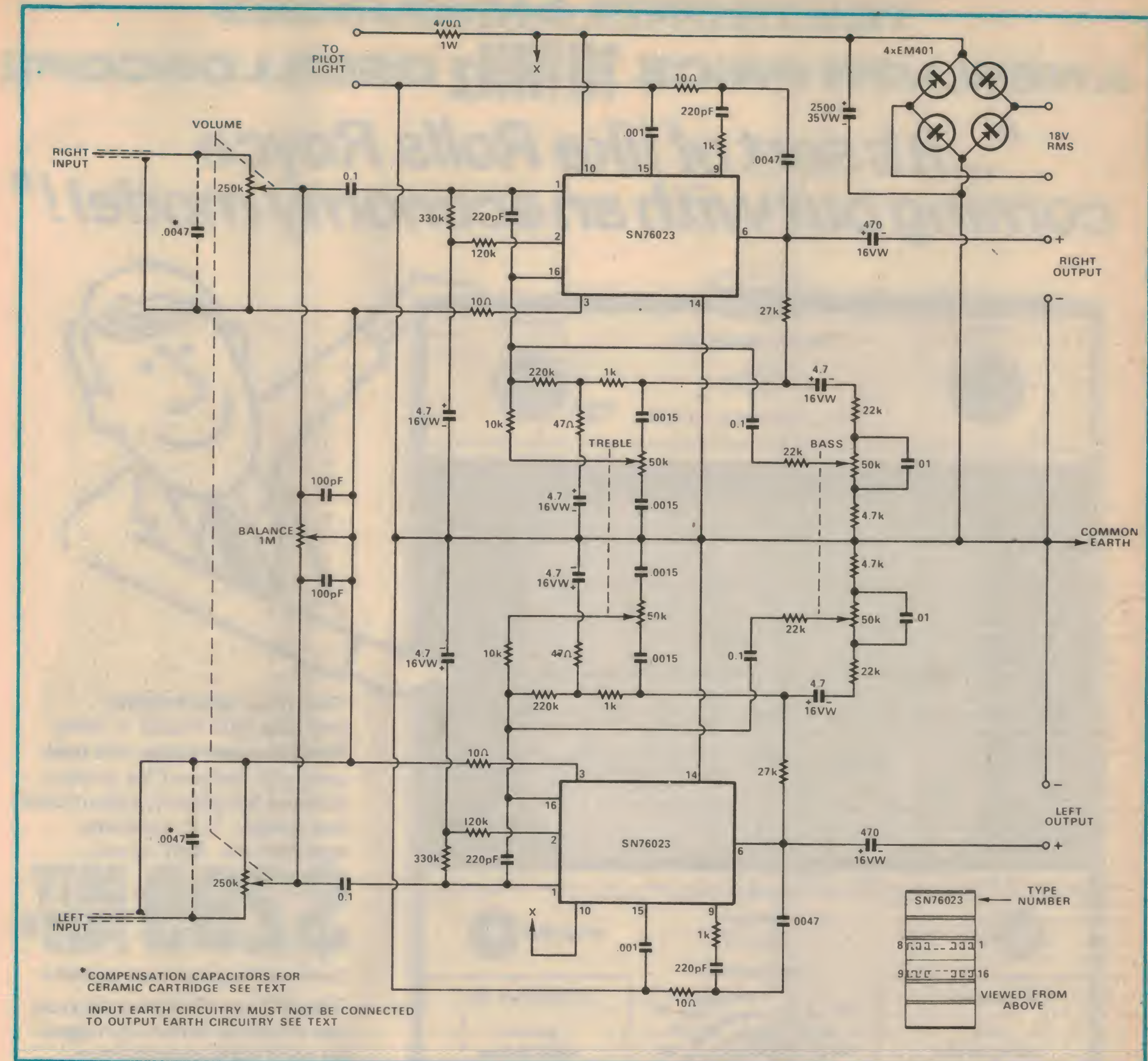
Another facility that we have provided is a headphone socket. This has been wired so that the speakers are automatically disconnected when a pair of headphones are plugged in. Attenuating resistors are used so that the sound level in the headphones is subjectively the same as that of the speakers. A further bonus is that the signal is fed to the tape recorder when the headphones are used, so that if it is required to record without using the speakers, it is a simple matter to plug in the headphones or a dummy plug.

The headphone socket, power switch and pilot light are located on the front panel of the amplifier, while the speaker and DIN sockets are located on the rear panel of the plinth.

The turntable we elected to use was a BSR model No G11202, with a matching wooden plinth fitted with a hinged perspex cover. The cartridge fitted was a typical ceramic model.

The transformer we have elected to use is one of the new low height range made by Ferguson. The recommended voltage for the SN76023 is specified as 28V maximum. Theoretically, a 20VRMS transformer coupled to a full wave silicon bridge rectifier would give a no-load voltage of 27.1 volts, allowing for a 1.2 volt drop in the bridge, which would be within the allowable limits for the SN76023. Unfortunately, due to the rather poor regulation of low-profile transformers, such an arrangement gives a much higher no-load voltage. As a result, we found it necessary to use a lower voltage transformer.

Our choice was the PF3598 transformer, which has two 9 volt secondaries, rated at 1.1 amps each. We connected these in series, to give an 18 volt 1.1 amp rating. This gave us a no-load voltage of 26.5 volts,



although due to the poor regulation the full load voltage drops to 21 volts. These values are within the limits of the SN76023, but the low full load voltage does limit the power available. However the power produced with this transformer should be found quite sufficient for most purposes. A practical listening test in a normal home environment proved this point.

A larger transformer with better regulation could be substituted, but care must be exercised that under no circumstances does the voltage applied to the SN76023 exceed 28 volts, the recommended maximum.

On the circuit board, we have made provision for two filter capacitors. However, we found that a single 2500uF unit gave acceptable performance. Some improvement to the peak power performance could be expected if a second such capacitor was used also, but this would be the only improvement, and a minor one at that.

The amplifier has been designed to use only ceramic or crystal cartridges, as the sensitivity and input impedance are not suitable for use with magnetic cartridges. Provision on the circuit board has been made to mount the required compensation capacitors, if the unit is to be used only with the record changer. Since we have provided extra inputs, we have not mounted these capacitors on the board, but on the tag strip used to terminate the flexible leads from the cartridge on the underneath of the turntable.

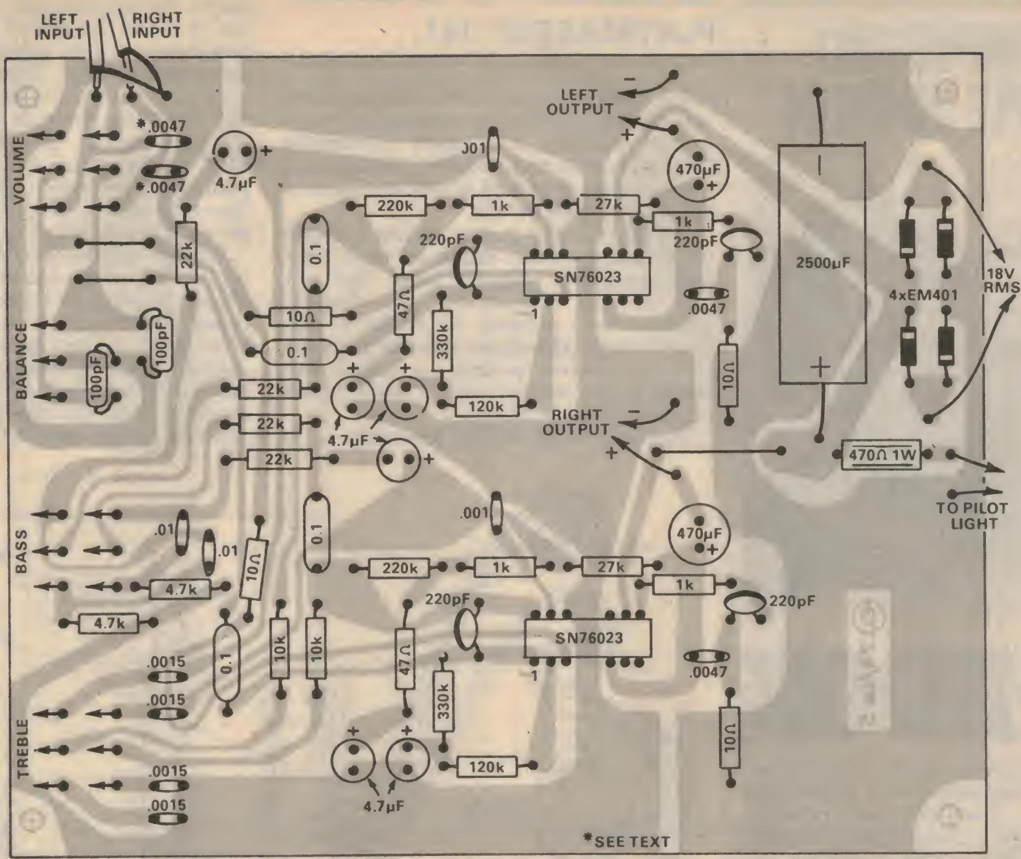
The internal circuitry of the SN76023 is quite different from that employed in the SL403D as used in the Playmaster 137. The internal circuitry of the SN76023 consists of a differential amplifier, a constant current source and a power amplifier. The DC quiescent conditions are set up by the constant current source using an external resistor combination, with the output of the differential amplifier forming the input to the power amplifier.

This configuration is similar to that used in operational amplifiers, so that the external circuitry is also similar to that used with operational amplifiers. The input signal is applied to pin 1, the non-inverting input, and a feedback signal, frequency compensated by the tone control circuitry, is applied to the inverting input, pin 16. Input and output compensation is applied to pins 15 and 9 respectively.

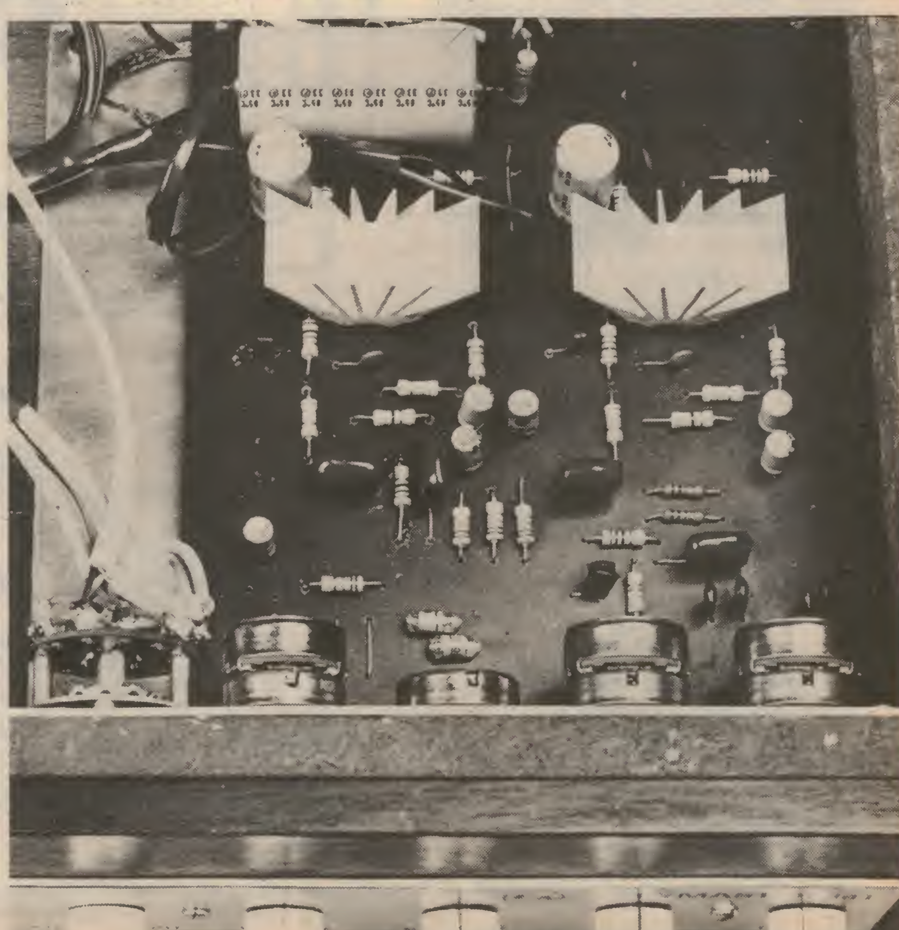
Pin 2 provides a reference voltage, which is coupled to pin 1 to set the quiescent voltage at the output (pin 6).

There are two earths on the SN76023. Pin 3 is the input earth and pin 14 is the output earth. In order that the circuit is stable, it is necessary that these earths be electrically separated. This has been done on the printed circuit board, and in order to obtain maximum performance, the wiring instructions should be strictly followed.

The SN76023 is recommended for use with 8 ohm speakers. Higher impedance speakers may be used, but with a consequent loss of power output. Speakers with an impedance of less than 8 ohms must not be used, as damage to the output transistors may result.



The component overlay on the printed wiring board is shown above reproduced actual size. Below is a view showing the completed board mounted on its chassis in the plinth.



No automatic overload protection is incorporated in the SN76023, but the massive design of the output transistors and the use of the large heatsink is claimed to give the device a life of greater than 10 years under normal use. A continuous output power of 5 watts RMS is claimed over a temperature range from 0 to 70 degrees Celsius.

The first step in the construction of the amplifier is to carefully inspect the printed circuit board for any possible faults, such as insufficient etching of the copper. Any shorts between adjacent connections should be carefully removed with a sharp razor blade or similar tool.

The three straps on the top of the board can now be placed in position. We made them out of short scrap lengths of 22 gauge wire. Cut-off component leads make a good substitute, as well as being inexpensive. There is no need to insulate these connections, as there is no danger of short circuits occurring.

The next step is to prepare the components for mounting on the board. The resistors and smaller capacitors should be mounted first, followed by the larger capacitors. The rectifier diodes and the integrated circuits should be the last components to be mounted, as these are most likely to suffer damage during this process.

All the resistors should have their leads bent at right-angles to their bodies, with the exception of the 470 ohm 1 watt resistor, which should be mounted standing on its end. Care must be exercised during this process, as some of the resistors have a longer distance between their mounting holes than others.

After all the resistors have been mounted on the board, a check should be made that no errors have been made. Once this has been done, the smaller capacitors can be

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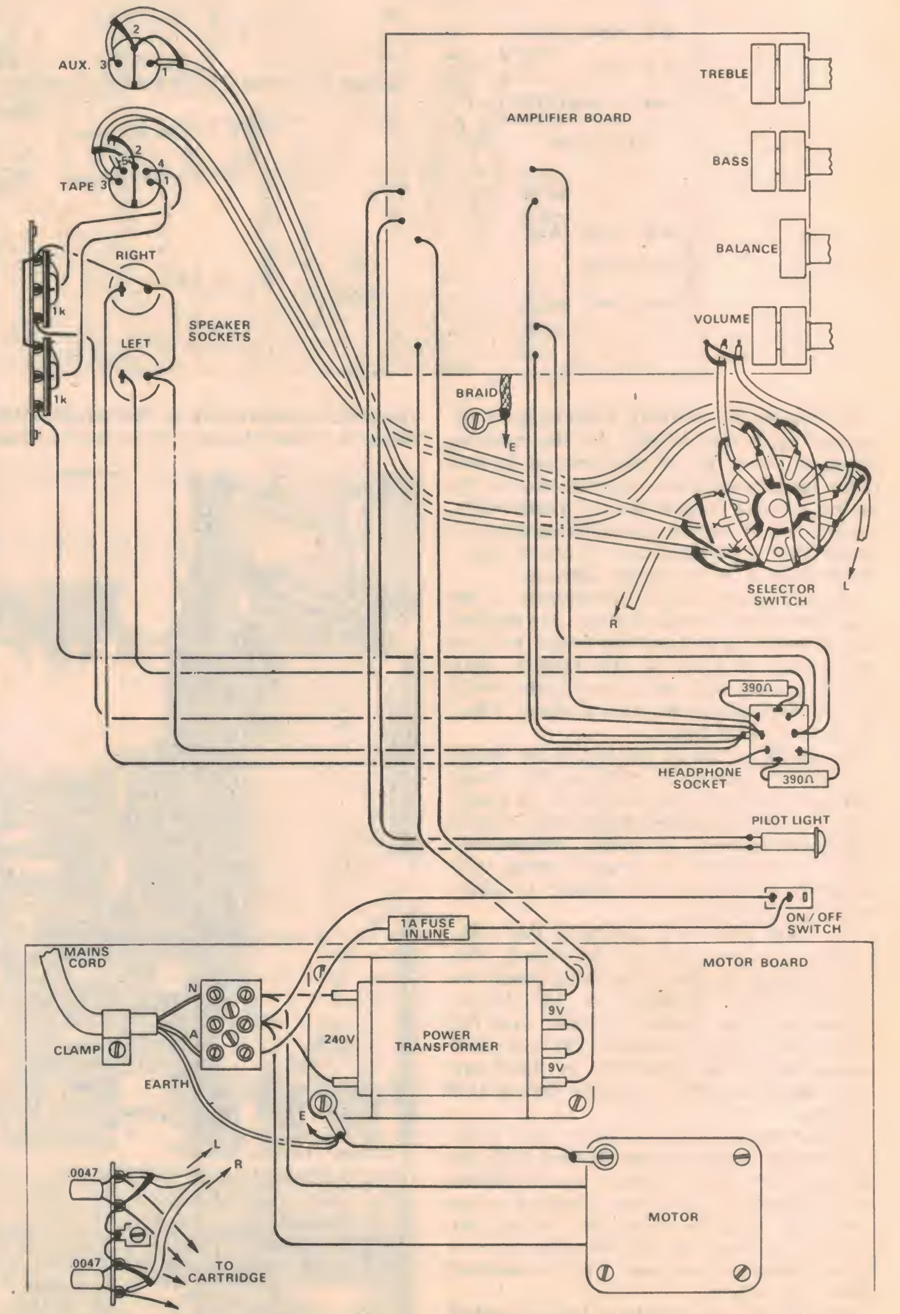
mounted on the board. Care should be taken that the electrolytics are mounted with the correct polarity. The large electrolytic filter capacitors may be left off the board at this stage, as they tend to obscure some of the smaller components.

The four rectifier diodes can now be fitted to the board. Before doing so, bend their leads around in complete loops. This will help prevent mechanical and thermal stresses from causing the diodes to fail prematurely. The diodes must be mounted with the correct polarity — details are shown in the printed wiring board layout diagram on page 59.

The next stage of the assembly is to mount the potentiometers onto the board. Cut 21 40mm lengths of 22 B & S gauge tinned copper wire, and solder these to the potentiometer lugs. These form the connections to the board. They must be suitably bent so that the shafts of the potentiometers will pass through the holes in the chassis when the board is placed in the correct position on the chassis. Once this has been done they may be soldered to the board and the ends trimmed to the correct length.

Suitable lengths of hookup wire can now be soldered to the board, as shown in the wiring diagram. If these wires are colour coded, it will be easier to identify them at a later stage. A short piece of copper braid should also be soldered to the copper of the pattern near the speaker earth for the left channel. Once this has been done the integrated circuits can be fitted to the board.



This diagram shows details of the input and switch wiring and the power supply, headphone and speaker connections. The power transformer is mounted on the underside of the baseboard.

The SN76023 has its type number and the "Texas Instruments" trade mark printed on the top of the heatsink fin nearest to pin 1. It must be mounted so that this pin corresponds to pin 1 on the circuit board, which is marked with a "1" on the copper pattern. Do not mount the SN76023s using integrated circuit mounting sockets, as these tend to cause a deterioration in performance and stability. Solder them directly to the circuit board, using a hot soldering iron and a minimum of solder. It is not necessary to solder those pins which are not connected to the circuit (pins 7, 8 and 11).

The electrolytic filter capacitor can now be added to the board, ensuring that the correct polarity is observed. The board should now be thoroughly checked to ensure that all components have been fitted in the correct place and with the correct polarity. This is important, as a mistake could lead to failure of the SN76023s.

The completed board is now ready to be attached to the chassis. This is done using four 10mm brass spacers with screws, nuts and lockwashers. The potentiometer shafts should be fitted through the corresponding holes in the chassis and the nuts and lockwashers supplied with them fitted. When this is done, the holes in the board should correspond to the holes in the chassis. If this is not so, bend the wire links holding the potentiometers onto the board.

We used threaded spacers, and mounted the spacers onto the chassis using countersunk head machine screws. These were let into the bottom of the chassis so that it could sit flush with the bottom of the plinth. We then used roundhead machine screws to attach the board to the spacers. The lockwashers were fitted under the spacers, so that the spacers were locked to the chassis. A solder lug should also be fitted to the spacer nearest to the copper braid from the board.

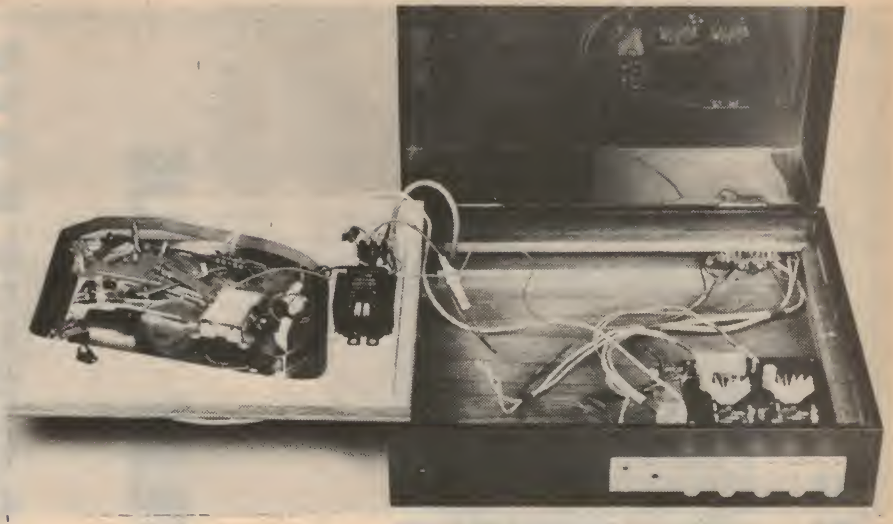
The board can now be screwed onto the spacers, taking care that no short circuits occur between them and the copper pattern. The copper braid forming the main earth point can now be soldered to the lug.

Before the selector switch is fitted, one pole of the connections should be shorted out. This will provide a common tie point for all the shields of the input cables.

The switch can now be fitted to the chassis. The locating lug matches with the small hole underneath the 9.5mm (3/8in) mounting hole. Using twin shielded cable, the connections to the circuit board can be made. At the circuit board, both shields are connected together and then soldered to the board. At the switch, the shields are also connected together, and are soldered to the four commoned terminals of the switch.

The shielded cables for the auxiliary inputs, the tape inputs and the pick-up inputs can also be connected to the switch. The shields of all these cables are connected to the four commoned terminals of the switch also.

Hold the chassis in place in the plinth, and place the front panel in position. Place the knobs on the control shafts, and measure the amount of shaft which needs to be cut off so that the knobs fit flush against the front panel. Allow a small clearance so that they do not rub on the panel. Then remove the chassis and cut the shafts to the correct length. Be careful that the filings from the cut do not adhere to the circuit board, where they could cause short circuits.



This photograph clearly shows the respective mounting positions of the printed wiring board assembly, the power transformer and the tagstrip carrying the two 1k trimpots.

SPECIFICATIONS

Power: 4 watts music power per channel into 8 ohm loads with one channel driven; 3.1 watts (continuous) per channel into 8 ohm loads with both channels driven simultaneously. 4 ohm loads must not be used.

Distortion: 0.3 per cent THD at 1kHz at 3 watts; 0.5 per cent THD at 1kHz at 0.5 watts.

Signal-to-noise ratio: Better than -56dB with respect to 3 watts into 8 ohm loads.

Channel separation: Better than -45dB at 1kHz at 3 watts.

Frequency response: 40Hz to 45kHz, +0dB -3dB (with tone controls set for flat response).

Tone controls: Bass control, 10dB boost and 8dB cut at 100Hz; Treble control, 4dB boost and 8dB cut at 10kHz.

Input sensitivity: 55mV for all inputs to produce 3.1 watts power output.

Input impedance: Greater than 100k.

LIST OF COMPONENT PARTS

2 Texas Instruments SN76023 audio amplifier ICs
1 Power transformer 240V primary, 9V + 9V secondary at 1.1A rating. (Ferguson PF3598 or similar)
2 Loudspeaker plugs and sockets with polarised pins
1 5-pin DIN plug and socket
1 3-pin DIN plug and socket
1 Printed board EA 74 / sa5
4 Diodes, EM401 or similar
1 1M linear potentiometer
1 250k log potentiometer (dual gang)
2 50k log potentiometers (dual gang)
1 3-pole 3-position rotary switch (MSP No. AK52253 or similar)
2 1k preset linear potentiometers
5 knobs
1 6-lug tag strip
1 Stereo headphone jack (double pole / double throw)
1 240V toggle switch
1 6V bezel (Ducon "BFB" or similar)
1 In-line fuse holder and 1A fuse
1 10A 3 pin power plug
2 metre 240V flex
1 mains cord clamp
1 3-terminal block
2 metre twin shielded cable
1 Turntable, plinth and cover
1 Chassis (see text)
1 Front panel (see text)

RESISTORS
4 10 ohm
2 47 ohm
1 470 ohm 1 watt
4 1k
2 4.7k
2 10k
4 22k
2 27k
2 120k
2 220k
2 330k
2 390 ohm

CAPACITORS
2 100pF 30VW
4 220pF 30VW
2 1000pF 30VW
4 1500pF 30VW
4 4700pF 30VW
2 .01uF 30VW
4 o.1uF 30VW
6 4.7uF 16VW electrolytics
2 470uF 16VW electrolytics
1 2500uF 35VW electrolytic

MISCELLANEOUS
Hookup wire, solder, solder lugs, screws, nuts, lockwashers, 22 B & S gauge tinned copper wire, copper braid.

Note: resistor wattage ratings and capacitor voltage ratings are those used in our prototype. Components with higher ratings may generally be used provided they are physically compatible. Components with lower ratings may also be used in some cases, providing ratings are not exceeded.

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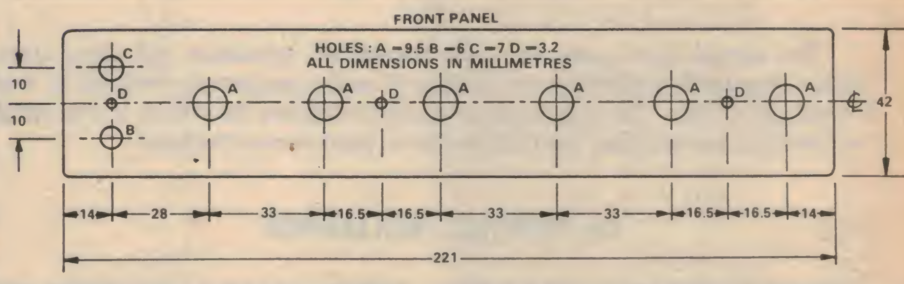
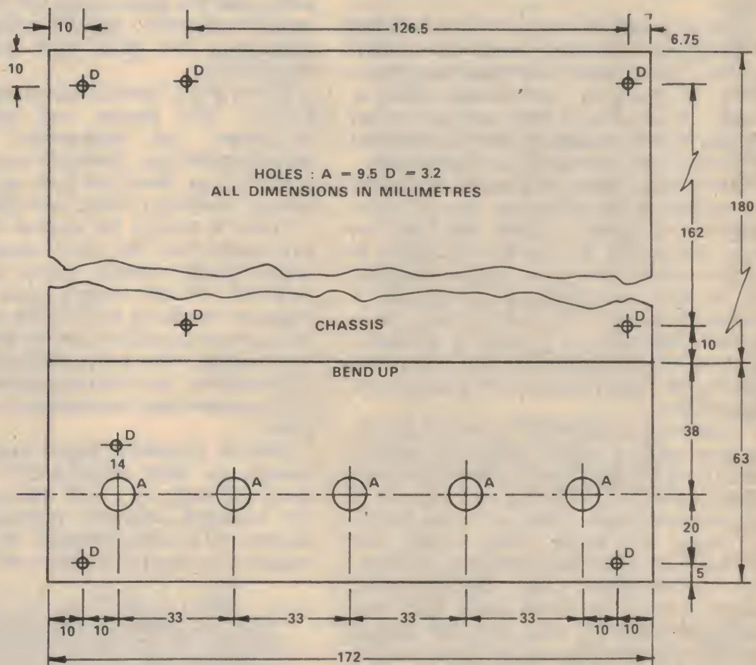


The front panel layout can be easily duplicated by the photograph at the top of the page and the metal work diagram immediately above. Below is the metal work diagram for the chassis onto which the printed wiring board is mounted.



The completed chassis is mounted in the right front corner of the plinth. Woodscrews are used to hold it in position against the front of the plinth. The shafts from the potentiometers and the selector switch project through the front of the plinth.

The wiring for the speakers can now be completed. The speaker leads from the board must be passed through the hole in the front panel where the headphone socket will be mounted. Solder the two 390 ohm resistors to the socket in the positions shown in the wiring diagram, making sure that they are positioned so that the socket will still pass through the hole in the plinth.

Mount the two 1k trimpots on the tag strip, and screw this to the rear of the plinth, just above the mounting holes for the speaker plugs. Solder the remaining wires to the headphone socket, pass them through the socket mounting hole, and solder them to the speaker plugs and the correct tags on the tag strip. Take care not to interchange the wires for the left and right channels — the connections must be as shown on the wiring diagram. The earth wires connecting the trimpots to the speaker sockets can now be added.

The wires from the centre terminals of the trimpots can be connected to the tape socket. Note that no earth connection from the speaker wiring is made to this socket, all the earth currents flow via the shields of the tape input cables. These can now be soldered to the tape socket, ensuring that pin 2 and the shield of the socket are connected together. The shielded cable to connect the auxiliary input can now be soldered to the auxiliary input socket, remembering to connect the shield of the socket to pin 2. These sockets can now be attached to the plinth.

Using the nut and washer supplied with the pilot lamp, attach it to the front panel. Pass the two wires from the printed circuit board through the correct hole in the plinth, and solder them to the light. The front panel can now be screwed to the plinth. It is held in place by three screws situated between the potentiometer shafts, using small round-head wood screws, as these are visually the most pleasing.

The headphone socket, the mains switch and the knobs can now be fitted in position. Before fitting the mains switch, solder suitable lengths of hook-up wire to the contacts and then insulate them with electrical tape. Ensure that the switch is fitted with the off position uppermost.

The record changer can now be mounted on the baseboard. Carefully read the instruction booklet which accompanies the changer before commencing. Once this has been completed, place the changer and baseboard upside down next to the plinth, in the manner shown in the photograph. This will facilitate the installation of the final components.

The 240VAC wiring can now be completed. Screw the transformer and the terminal block to the underside of the baseboard. The mains cord is passed through a hole in the rear of the plinth, and anchored to the baseboard. The active and neutral wires are terminated at the terminal block, while the earth wire is terminated at a solder lug attached to one of the mounting screws of the transformer. This earths the transformer.

An earth wire is also run from this lug to the turntable motor. It is attached to a solder lug mounted on one of the assembly bolts of the motor. A second earth wire is used to join the transformer earth to the chassis of the amplifier.

A wire is run from the active terminal of the terminal block through the in-line fuse link to the mains on / off switch, and then back to the third (centre) terminal. The turntable motor and the transformer are then wired in parallel between this terminal and the neutral terminal.

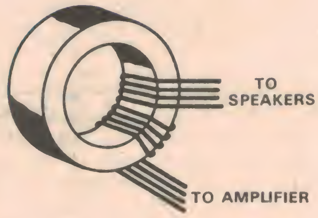
The two 4700pF capacitors can then be wired across the tag strip to which are attached the wires from the cartridge. Check that the green and black wires are connected together and to the centre mounting lug of the tag strip. This forms the earth connection of the turntable (but not of the turntable motor). The shielded cable from the selector switch can then be soldered to the tag strip, making sure that the right channel is connected to the red wire and the left channel to the white wire. The shields are connected to the green and black wires respectively.

The amplifier is now complete, and the plinth can be assembled. Take care that the cables and wires underneath are not jammed under the baseboard. Before proceeding further, check that the arm of the player is correctly balanced. Do not forget to remove the protective stylus cover before carrying out this procedure.

Connect up a suitable pair of speakers, plug the mains cord in to a suitable receptacle, and switch on the power. A small plop should be audible from both speakers immediately after switch on. This is normal. Place a record on the platter, turn the selector switch to "PU" and operate the player. Check that all controls function normally. If suitable sources are available, the operation of the "AUX" and the "TAPE" positions can also be checked.

Toroid filter minimises radio, TV breakthrough

The signals from powerful radio broadcast, television and other transmitters frequently penetrate the circuits of audio equipment installed in their immediate vicinity. The simple precautionary measure described in this article may provide a way out of the problem for at least some listeners.



by NEVILLE WILLIAMS

Powerful RF signals may penetrate audio circuits in a number of different ways, of which the best known is probably via the input wiring to high gain preamplifier stages.

Because amplifiers have to be connected to peripheral devices such as record players, tape players, microphones, etc, a metre or more of connecting cable is usually involved and this can act as an antenna to pick up signal from the powerful RF field in the vicinity of a transmitter.

When a preamplifier is capable of driving the system to full output on two or three millivolts of signal, it does not take too many microvolts of spurious RF input to produce some kind of an audio resultant and, at least, an annoying background of unwanted sound. The sound may be a distorted murmur, or it may be recognisable program material, or it may be a raspy 50Hz frame buzz from a television picture transmitter.

Precautions against RF penetration into the front end of audio equipment include minimising the length of connecting leads, complete metallic shielding and the use of twin balanced leads right up to the amplifier input, the leads being inside, but isolated from, the outer shielding. Additionally, the amplifier may include small chokes in series with the audio leads immediately inside the case, plus RF bypass capacitors across the active input circuit.

Occasionally, RF can penetrate the early circuits of an amplifier directly, rather than via filtered input leads. Modern transistor amplifiers are actually more prone to this than their earlier valve counterparts, because their pass-band is intrinsically wider and because they may more readily overload on — and rectify — RF energy. While direct RF penetration is not common, an amplifier housed in a metal rather than a non-metal cabinet may be a good investment for installations within the shock area of a powerful transmitter.

RF which penetrates an amplifier system via the input or early stages can usually be identified because it is subject to normal volume control action. It becomes louder or softer as the control is advanced or retarded.

If the interfering signal is not affected by the volume control, there is a strong possibility that it is penetrating the power output circuitry directly, and the chances of this happening are quite high with modern amplifiers.

There are a number of reasons for this. Firstly, with stereo and quadraphonic equipment, the loudspeaker leads are usually quite long. They are rarely shielded and they can therefore pick up a lot of RF energy, feeding it back into the amplifier.

There is always the chance that the RF can couple into the early circuits and be subject to the volume control. More likely, however, it will simply pass along the negative feedback loop to the input of the main power amplifier and be treated as an input signal. Given the slightest amount of non-linearity, and the modulation it carries will emerge from the system as a spurious sound.

Modern transistor power amplifiers are notable for their intrinisically wide passband and their very high loop gain around the feedback network. Because of these factors, it is very difficult to limit their response internally to audio only. With integrated circuits, it is even harder than with discrete components.

Thus, while the "built-in" precautions against RF penetration may be adequate for ordinary situations, it is not uncommon for modern amplifiers to give trouble in shock areas.

Additional RF bypassing across the loudspeaker leads may not be effective because of the very low impedance of the circuitry, besides which added capacitance may have an adverse effect on amplifier stability. Shielded loudspeaker leads could suffer the same criticism, besides being expensive and cumbersome.

Faced with just this situation, the writer has come up with a solution which may or may not be original, but which certainly works like magic. The persistent background murmur from a nearby broadcast transmitter has been reduced to complete silence.

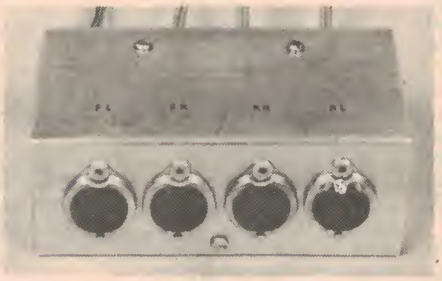
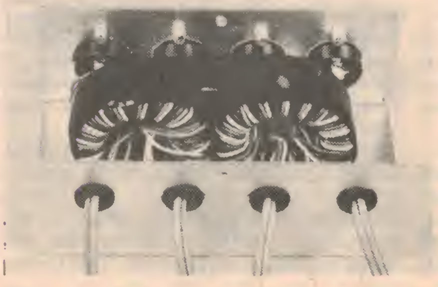
A very faint buzzing hum also disappeared, which had obviously been coming from the four not-too-distant TV transmitters. As a further and quite unexpected bonus, a switching transient from the refrigerator was also reduced indicating clearly enough that it, too, had a substantial RF component, radiated from the mains, rather than being coupled in via the amplifier power supply.

There are four loudspeakers in the particular listening room, one pair relatively close to the equipment shelf, the other pair about thirty feet away. Depending on circumstances, the systems may be used as separate stereo pairs or as components of a quadraphonic system. The interference problem has centred mainly around the distant pair of loudspeakers and their long connecting leads. Whenever they were connected to a solid-state amplifier, there was a strong chance of getting free background music from the nearby transmitter!

The "magic" cure?

Beg, borrow or buy an ordinary ferrite toroid, typically 3 to 4cm outside diameter. They are so scarce these days that you probably won't have to pick and choose between types, but don't let that worry you. Use what you can get.

The idea is to wind the loudspeaker leads through it as many times as possible, just before they enter the amplifier, so that they become part of a lumped series inductor. This assumes, of course, that the leads are not too bulky and that you don't mind temporarily removing the connecting plugs.

Filter for a 4-channel amplifier assembled in a small aluminium box.

Since evolving the filter and writing the article, we came across a similar device and a similar line of thinking in the latest issue of "Hi-Fi News & Record Review". Contributor Harry Leeming had also "invented" the loudspeaker toroid filter!

In our own case, the leads were heavy, rather stiff figure-8 flex and we made up a separate prototype filter with plugs and sockets attached so that it could be located just behind the amplifier. It was this plug-in unit that so proved the point so effectively.

To make it up, we obtained a suitable toroid and four lengths of thin hook-up wire, of different colours and each about 1¼ metres long. We wound the four leads through the toroid, getting on about twenty turns of the four-wire group, without any great trouble. Taking care to preserve loudspeaker identity and polarity, we connected one set of ends to the amplifier output circuitry and the opposite ends to the loudspeakers.

The interesting point about such a unit is that the circulating currents for each loudspeaker cancel in the toroid so that the amplifier does not see the toroid as a series inductor. For the same reason, there is no tendency for coupling between the individual loudspeakers.

However, for RF fed into the loudspeaker cables from the transmitter field, the toroid looks like a substantial inductive impedance. In the writer's case, this rough filter in series with the two longer leads virtually solved the problem, since RF penetration via the shorter leads was of no consequence.

We did not try to take the idea further to see just how many or how few leads would suffice, on what kind of toroid, and in the presence of what kind of signal. For the purpose, about 20 turns per lead through an over-the-counter toroid worked fine and the idea is there for you to work on if you face a different set of circumstances.

In fact, if you can't put your hands on a toroid, the idea would probably work with a ferrite pot core. There might be a problem in accommodating the requisite number of turns, however, even using fine wire; the core would also have to be clamped shut.

We would be hesitant about a ferrite rod because it could actually pick up RF and feed it into the loudspeaker lines!

So much for the basic idea. But it would surely be a pity to spoil it by keeping it simple!

Thus encouraged, we made up a unit as pictured, using two toroids in a small folded aluminium box, with sockets attached and plugs on the ends of trailing leads. This is intended as a permanent part of the system or, at least, to be on hand when it is needed for any particular amplifier, be it stereo or quadraphonic.

For this unit, we stripped the four fine colour-coded wires from a length of plastic coated 2-pair telephone cable, which can be bought from some suppliers. With care, it would probably have been possible to wind eight wires for a complete quadraphonic system through the one toroid but we had two toroids and it saved us from having to sort out the pairs of colours.

The toroids were wound, insulated separately and then strapped together with adhesive tape, so that they would remain in position in the case. Just to make sure, we pressed a piece of sponge plastic over them before finally assembling the case.

One special word of warning: Whatever wire you use and whatever method you use to put it together, make sure that three is no short-circuit across any one loudspeaker or between loudspeaker wiring. Solid-state amplifiers don't take kindly to a shorted output circuit!

A solid state audio distortion factor meter — 2

In this second article describing an easily built solid state distortion meter for audio enthusiasts, the author deals with the calibrated attenuator and metering circuit. He also discusses physical construction, calibration and use.

by F. G. CANNING, FIREE (Aust)

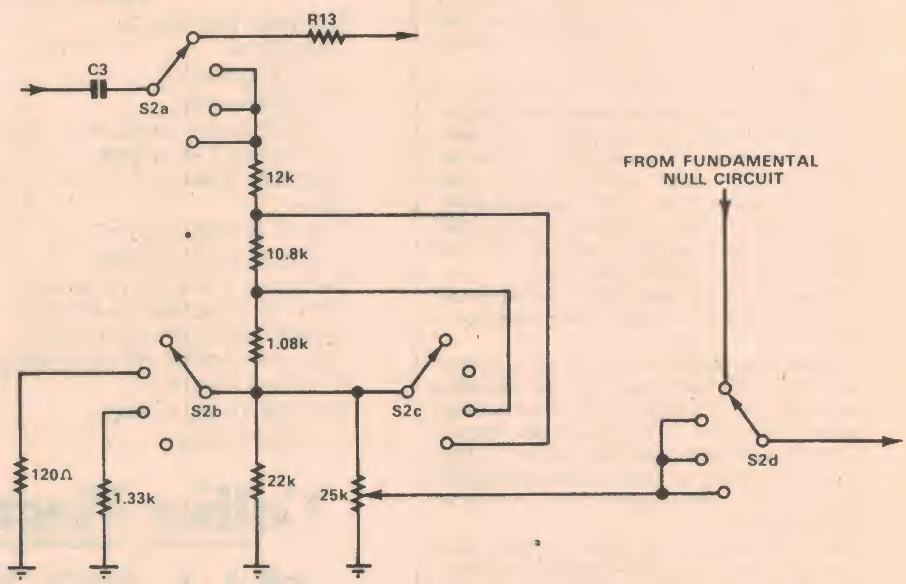
The Calibrated Potentiometer. Essentially this is an accurate potential divider having three ranges, with an input resistance of 24k on all ranges. When the Function Switch S2 is set to the X1 position the output is 0.5pc of the input, while in the X10 position the ratio is 5pc and in the X100 position it is 50pc. The fine calibrated control is provided by RV5, a 25k linear wire-wound potentiometer which should be of good quality and fairly large — say 2in diameter or more. It carries the scale from which Distortion Factor is read, calibrated from 0 to 0.5pc. As the required value for this control is 12k ± 1pc it is shunted by a fixed resistor of nominal 22k, chosen from a number of samples to give the parallel resistance and tolerance required for the combination. The rest of the fixed resistors should also be of 1pc tolerance.

If the potentiometer has a metal cover this must be earthed to the panel. All wiring to this control must be well screened and earthed.

The Function Switch S2 is a six-pole four-position rotary switch of the usual type, with three decks each carrying two poles. A two-deck switch would be crowded, with more risk of unwanted capacitive coupling between circuits. S2D and S2F (see Fig 6) are on the deck nearest the front panel, S2C and S2E on the next deck and S2A and S2B on the outermost one. This brings A, C and D in a vertical line, likewise B, E and F. The associated fixed resistors are mounted directly on the switch contacts. The non-standard values are obtained by using two standard-value 1pc tolerance units in series, eg 1k and 80 ohms for 1.08k, 100 and 33 for 133 ohms, and so on. This has the incidental advantage that the overall tolerance of the combination may be closer than that of the individual resistors, since limit tolerance in the same direction on both components is unlikely.

It has been suggested that the switching could be simplified by the use of a four-pole switch with a modified circuit as shown on this page. I have not tried this, but it may well be satisfactory. To reduce the risk of signal feedthrough due to stray capacitance, S2A and S2D should be on separate wafers and on opposite sides of the switch centerline. The wafers should be well spaced.

The distortion scale for the variable potentiometer can be made with the aid of a small circular celluloid protractor, as sold cheaply by stationers for school use. It is only necessary to devise a temporary mounting, either directly on the spindle and rotating with it or else stationary with a temporary pointer running over its scale; it must, however, be truly concentric with the spindle. Most such protractors have cross-lines to indicate true centre. With an ohmmeter connected successively between each end and the slider, determine the exact point on the protractor at which the resistance reading departs from zero (not necessarily the end-stop points) at each end. Read off the number of degrees between these points, divide by five to get the degrees separating the five cardinal points of the proposed scale, ie 0.5%, 0.4%, etc, down to zero and then further sub-divide these divisions as finely as desired. The writer used ten main divisions only, intermediate readings being easily estimated by eye. Once determined, these same divisions can be laid out with the same protractor on a suitable piece of card or plastic to form the scale of the instrument.



A suggested modification to the circuit given last month, which simplifies the function switch wiring and saves one section. The author has not tried it, however.

The Meter Circuit. This is a four-stage negative feedback amplifier driving a 0-100 microamp meter through a somewhat unusual silicon rectifier bridge. Its function is to compare the outputs of the calibrated potential divider (total signal) and of the notch filter (distortion and noise only) when brought to a standard reference reading. Therefore it is an indicator only, but as previously mentioned its essential requirements include a response flat within 1dB from 20 Hz to 100 kHz, a sensitivity of at least 200 microvolts for 70pc of full-scale reading, and a high input resistance. This sensitivity requires good screening and full precautions against instability, since the scope for in-phase feedback and consequent oscillation is considerable. In final form it has proved quite stable and reliable and could well form the basis for a separate multi-range micro / millivolt meter with complete scale calibration for general use. The input impedance is around 100k and the meter shows no measurable noise.

Overall negative feedback from output to input proved difficult to stabilise, so multiple feedback paths were adopted, all DC coupled except that through the output meter. It also proved necessary to split the amplifier into two physical sections screened from each other by flat screening plates, and to decouple the first two stages from the battery supply by a 1k resistor and 220uF capacitor.

Input is through a non-polarised electrolytic capacitor of 4uF, or else two 10uF normal tantalum units connected back to back. Minimal leakage current is vital here. Tr6 is operated at very low collector current to minimise noise and has some DC feedback from collector to base. Its emitter bias resistor consists of a 220 ohm trim-pot connected as a variable resistor and it serves to set the ultimate sensitivity of the whole meter circuit. It will normally be at the full resistance setting, but it can be used for close adjustment of gain by those who have a metered audio source and a tem-

*30 Back Beach Rd, Portsea, Vic 3944.

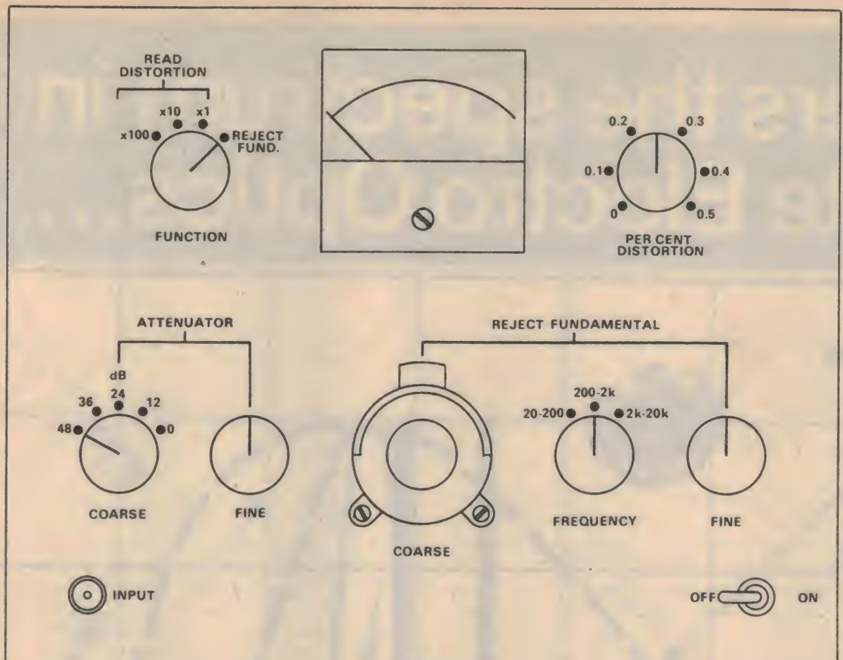


FIG 9

Fig 9: The author's suggested layout for the front panel of the distortion meter. The meter movement is a small 100uA imported type.

porary input pad to give a calculated 200 microvolts of signal. Stable and almost noise-free sensitivities down to 50 microvolts have been achieved experimentally but are not needed here.

DC feedback is applied between Tr7 collector and base and also from collector to Tr6 emitter. These two stages, together with the decoupling components, are assembled on their own small Veroboard panel and mounted on, and closely spaced from a flat earthed shielding plate of larger size. The other side of this plate carries the rest of the circuit upon another Veroboard panel, consisting of a further two-stage feedback amplifier using Tr8 and Tr9 in a circuit designed for high input and low output resistances. All transistors are of the high-gain type BC109C.

The rectifier and meter circuit, through which negative feedback is taken over two stages, first came to the writer's notice in an Application Note published by Ferranti Ltd. Unlike some rectifier-meter circuits it is linear over about three-quarters of its scale and is claimed to give virtually true RMS readings over this range. Its properties, including frequency response, can depend somewhat upon the amount of feedback used; in this case the complete circuit has flat response from 20Hz to beyond 200kHz but by reducing gain somewhat it could easily be made flat to 1MHz and beyond.

The meter is a 0-100 microamp type whose resistance is not very important and it can be of any desired size or style. The diodes are all silicon types; the series units are 1N914 and the shunt unit (in series with Tr9 collector) is a Texas Instruments 1S44. The two isolating capacitors are 22uF tantalum units for the sake of low leakage and other sizes down to 15uF could be used without much effect if more convenient. The relative polarities of diodes, capacitors and meter are shown on the circuit, "C" denoting cathode, and should be carefully noted for an error here can make the meter inoperative. This circuit has its own 9-volt battery supply with 220uF bypass capacitor and separate On-Off switch. The reference mark on the meter scale, indicated by a red line, was made at 70 microamps to give some scope for overswing during tuning.

CONSTRUCTION: This can take many forms to suit the constructor's ideas or available components, and no detailed plans are offered. A shielded case is required, either of metal (preferably not steel) or else of wood with internal metal shielding. The prototype used a case made up from ½" pineboard lined with aluminium cooking foil stuck on with adhesive; this unexpectedly proved effective. Zinc "flashing" or copper foil would be better and allow the seams to be soldered — very desirable. Fig 8 shows this box with rough dimensions, but these will vary with the components used.

The front panel, of 18 gauge aluminium, is faced with 1/16" white plastic sheeting of the same size. It carries the complete assembly apart from batteries, which must be housed inside the case to avoid noise pickup and should be insulated from the metal lining by waxed cardboard or other means to prevent noise due to leakage from battery to its outer case, which is not unknown.

A suggested control layout, used in the prototype, is shown in Fig 9. This lends itself fairly well to the necessary shielding behind the panel between sections and components which is, in principle, like Fig 10. Signal input is through a standard Phono socket and plug. The Japanese meter used has a round barrel and a face about two inches square. It was found necessary to provide a tight-fitting cylindrical shield 2" high around the barrel of the meter behind the panel and earthed to it, to eliminate feedback. It was made of Zinc flashing strip (not steel or tinplate) which is available from most builder's hardware stores. The seam was soldered and the twisted meter leads taken in through a hole drilled in the wall of the shield on the side of the shield remote from the rest of the circuit. These leads are "hot" and it may be well to use screened wire.

A 20 gauge hard aluminium dividing plate roughly 3in high by 9½in long runs horizontally across the rear of the front panel about 4in from the top edge and is mounted on a piece of ½in hard aluminium angle bolted to the panel. Holes are drilled in this plate where necessary to pass connections. It also carries an insulating panel of ⅛in sheet bakelite attached by further pieces of angle to the front panel and to the dividing plate; this panel carries the ganged capacitor and must be dimensioned to suit the capacitor used. Its mountings must be rigid and substantial, or there will be unwanted backlash in the capacitor drive which will be most frustrating.

The buffer amplifier for the input attenuator is assembled on a Veroboard panel about 1½in square, which is mounted on the dividing plate close to the attenuator controls. If much work on high-powered amplifiers is expected it would be worth while to enclose this and the coarse and fine attenuators and the input socket in a separate shield box bolted to the front panel for protection against the amplifier's stray signal field, which may penetrate the case

Fig 8: The case used by the author, made from ½-inch particle board. It should be lined with aluminium cooking foil, zinc flashing or copper foil to shield the wiring from external fields.

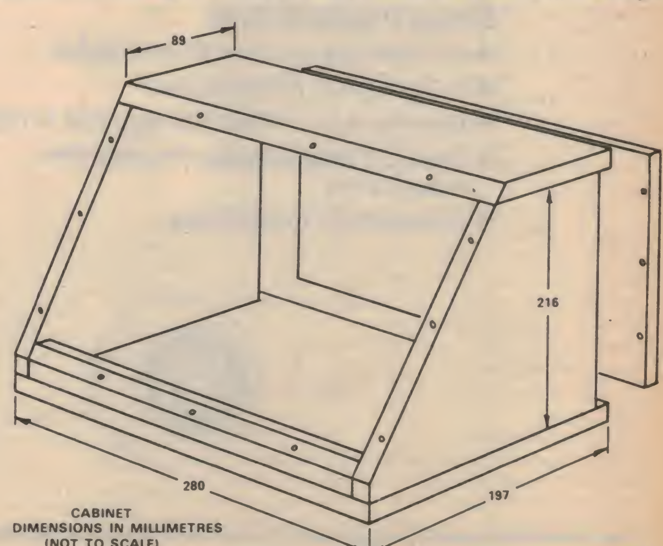


FIG. 8

Distortion Meter

and be picked up directly by the buffer stage.

The ganged capacitor will need some shielding from all other sections, but shape and size will depend on the component used. In the prototype a shield 2¾in wide rising vertically from the front panel between the gang mounting and the input attenuator and then bent horizontally over the gang for 2in and clearing it by ¼in was found sufficient.

The input attenuator switch S1 is a rotary single-deck Oak switch of one-pole eleven-way type but with its rotation limited to five positions. The associated fixed resistors are then mounted either across the switch from side to side for the shunt elements, or between adjacent live contacts for the series ones, making the whole assembly self-supporting. The 4.7uF coupling capacitor C3 should be a tantalum type, for low leakage. Earth the metal cover of the Fine Control potentiometer with a separate connection.

The notch filter was assembled on a 5in x 2in piece of 0.1in matrix board and mounted by bolts and nuts on the dividing plate parallel to it and alongside the ganged capacitor and Range Switch for short connections. It should be spaced ¼in or less from the dividing plate for good shielding and if contact is feared a sheet of thin celluloid can be used between them. The input connection is at the end nearest the Function Switch and output at the other. These connections, to S2A and S2F respectively, are made with 3mm shielded and PVC covered cable, with their shield coverings connected together at the switch ends and thence by a common insulated wire to the main earth point at the input socket. All circuit sections are, in fact, provided each with its own insulated earth wire and all are grounded only at the input socket.

The Range Switch is another single-deck Oak type, of two-pole three-way construction. The writer replaced the normal wafer assembly screws with two 1¾in lengths of threaded rod with nuts, and on the ends of these a two-way-tag-strip was mounted with more nuts, to provide the two common terminations for the six range resistors, thus making another complete sub-assembly mounted to the panel by a single nut. Tinned-copper twisted loops are used on the matrix board for the emitter and collector connections of Tr3 and the gate connection of Tr4 and short stiff connections go from these to the frame of the capacitor and to the common resistor terminations. The trimmer capacitors C6 and C7 must be freely accessible for initial balancing, also potentiometers RV3 and RV4 for screwdriver adjustment. A twisted pair of leads must be brought out from the matrix board for connection to the ten-turn potentiometer RV2 which is connected as a variable resistor. If a Beckman "Helipot" is used connect to its two rearmost tags, ignoring the third one.

The "ON-OFF" switch has to be a double-pole type to control the two separate batteries.

Coming now to the other side of the dividing plate, the two halves of the meter circuit are, as previously said, assembled on individual small Veroboards mounted one on each side of a shielding plate measuring

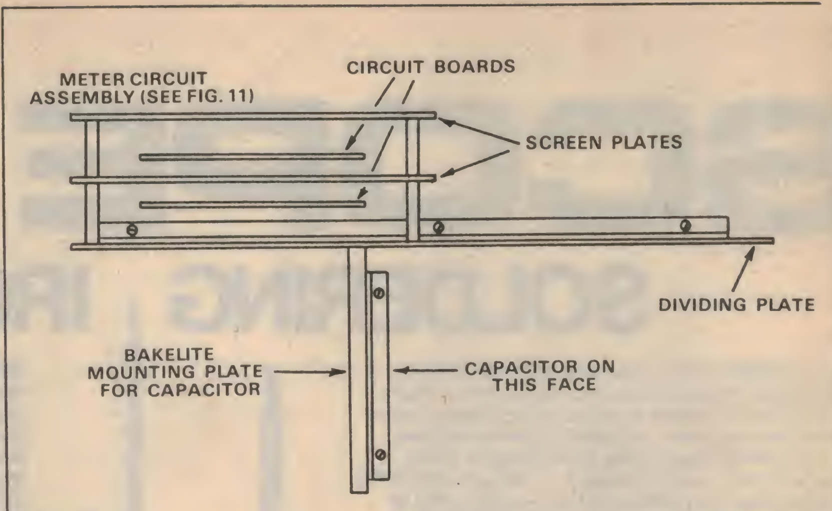


FIG. 10

Fig 10 above shows the basic construction of the unit, built on the front panel. At right, Fig 11 shows the meter amplifier assembly.

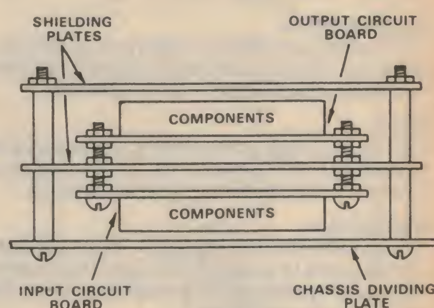


FIG. 11

5½in x 2½in. This is mounted by long machine screws and nuts to the dividing plate with the input section next to it, with about ¾in between the plates for good shielding. A further shield plate measuring about 3in x 2½in is then fitted over the output section of the circuit by long screws to the first-mentioned shield and separated from it by ⅝in, thus sandwiching the complete meter circuit. The arrangement is roughly shown in Fig 11. Input to section 1 and output from section 2 are arranged to be at the ends nearest the Function Switch and panel meter respectively, and the connections between sections at the other end, giving the shortest exposed wiring. Use 3mm shielded cable for the connection from S2F to meter circuit input, with braiding earthed.

Twin shielded and PVC-covered cable forms the three connections between the calibrated potentiometer RV5 and S2E, S2F and earth. As before, the earthy connection to the screening braid is insulated and carried right back to the main ground point at the input socket. The earth returns of R49 and R50 are also part of this system. R48 of 22k nominal resistance is mounted directly on the potentiometer tags. Don't omit to ground any metal cover on this potentiometer to its earthy terminal.

VOLTAGE ANALYSIS

	EMITTER (SOURCE)	COLLECTOR (DRAIN)
Tr 1	(2V)	(17V)
Tr 2	0.4V	3.5V
Tr 3	2.4V	5.8V
Tr 4	(5V)	(14V)
Tr 5	13.5V	18V
Tr 6	0.075V	4.4V
Tr 7	0V	2.35V
Tr 8	0.015V	1.2V
Tr 9	0.6V	5.0V

TOTAL CURRENT DRAIN
9 Volt Battery 1.2 mA.
18 Volt Battery 5.6 mA.

All voltages measured with 50 k / volt meter, with respect to chassis.

SETTING UP. This process requires an audio oscillator of reasonable waveform with an output controllable from 200 millivolts or more to zero, and also an oscilloscope or, failing that, a sensitive electronic voltmeter capable of reading down to 100 millivolts or less, with a high input resistance and a flat response over the audio range. The oscilloscope is preferable, especially if it has a "X10" facility switch on its vertical attenuator and an accurate graticule. Proceed as follows.

With the instrument temporarily in its shielded case to cut out noise pick-up, set the filter Coarse control (ganged capacitor) and Fine control (RV2) to around mid-range, the Frequency range switch to the 2-20kHz range, and the Function Switch to "Reject Fundamental." The sliders of RV3 and RV4 should be at their earthy ends. Set the input attenuator controls Coarse and Fine, to 48dB and zero respectively (fully anticlockwise.)

Switch on. The meter pointer will flick hard over several times during a period of five to ten seconds as the various large electrolytic capacitors gradually charge up to their terminal voltages and pass through some unstable regions on the way, but thereafter the needle should settle to a steady reading which should be fairly low if the testing area is reasonably free from electrical interference. An earth connection can be tried, but if it increases the meter reading discard it.

If all is well so far, remove the cabinet and proceed to the final adjustments. Set the controls as follows:—

1. Frequency range switch on 2 to 20kHz.
2. Filter Coarse control (capacitor) at 80 degrees, ie, around 2.5kHz.
3. Set input attenuator controls to zero attenuation, ie fully clockwise.

Distortion Meter

4. Connect audio oscillator to Input socket by plug and a shielded cable long enough to allow about two feet separation between the instruments.
5. Set oscillator to around 500Hz — not critical — and its output control to give around 200 millivolts.
6. Switch on both instruments. The meter will go far beyond full-scale reading during this process, but no harm will result.
7. Switch on oscilloscope and connect its vertical input to the input of the notch filter (the corresponding lug on the Function Switch S2A is convenient). With the 'scope attenuator Switch on "X1" adjust its fine attenuator control and, if necessary, the oscillator output control to give a steady trace of convenient height — say 3 or 4 divisions on the graticule. Note this height.
8. Transfer the 'scope output to the output of the notch filter (again, a convenient point is the Function Switch, lug S2F) and set the 'scope attenuator switch to "X10".
9. Adjust RV3 to give the original height of trace, thus giving the filter a gain of 10 times.
10. Re-set 'scope switch to "X1". Now adjust RV4 until the trace again returns to the original height; ie feedback has reduced the gain to unity which will now be the condition for all harmonic frequencies, but not for the fundamental ones which are being suppressed by the filter.
11. Return the 'scope to the filter input and compare to ensure that the signal amplitudes at input and output of the filter are now identical.

This completes the sensitivity / selectivity adjustments. The bridge capacities must now be balanced, and as this requires, full sensitivity and an accurate null it is best if the trimmer capacitors C6 and C7 are accessible with the instrument in its case but with back removed. In a "noisy" location it may be necessary to switch off all mains-operated equipment in the vicinity, including lighting if this is of the fluorescent type. Proceed thus:—

1. Set C6 and C7 to about half their range.
2. Set the input Coarse attenuator to 48dB and the Fine attenuator fully anticlockwise. Set the Function Switch to "Reject Fundamental," the Frequency range switch to 200-2kHz and the ganged capacitor to 15 degrees.
3. Switch on, allow a couple of minutes to settle down, and note the meter reading which should be quite low, around 5 microamps. This is the internal (transistor) noise of the instrument and is normal. (The batteries should be in their final position inside the case for this operation.)
4. If all is well, set the audio oscillator frequency to 2kHz and output to 200 millivolts roughly, and switch on. Advance the input attenuator controls until a reading of half-scale or more is seen on the meter. Now tune the variable capacitor VC1 / VC2 until a pronounced dip occurs, indicating an approach to balance at that frequency. Increase the attenuator setting to restore the reading and adjust the Fine balance control RV2, when a further dip will probably be seen.

Next set VC1 / VC2 to around 10 degrees on its dial, ie, with plates almost unmeshed, and re-tune the oscillator until the dip is again seen. From this point on continue to adjust both Coarse and Fine balance controls together (they will interact a little) while gradually increasing input until the best null is seen. It will be found very sharp and a steady hand on the controls is needed. The Coarse input control will now probably be at 0dB and the Fine control fairly well advanced.

Now the final adjustment can be made by altering one of the trimmer capacitors C6 or C7 while rocking the ganged capacitor around the null point with, if necessary, a touch on the Fine balance until the best possible null is obtained. This completes the process, and assuming a 200 millivolt input signal of about 0.1pc distortion and with zero attenuation, a meter reading somewhere in the upper half of the scale should be seen, representing the total distortion in that signal; a less pure input will give a higher reading and require some attenuation.

Set the attenuator to bring the meter to the reference mark. Now move the Function Switch to "Read Distortion" without touching attenuator or oscillator. Adjust the calibrated potentiometer RV5 to again give the reference reading on the meter, and read the distortion percentage from the scale of RV5.

A signal having more than 0.5pc distortion will require the Function Switch to be moved to the "X10" or even the "X100" setting. In each case the distortion reading on the scale is to be multiplied by that factor.

USE: High sensitivity requires that measurement of an unknown signal must be approached from the position of maximum input attenuation gradually increasing the input until the first meter reading is seen. At this point a rough null should be sought on the Coarse control (capacitor). The input is then slowly increased while following up the null, which gets progressively sharper, on both Coarse and Fine controls until no further improvement can be obtained. In the course of such a measurement the meter pointer will frequently go "off scale" fairly hard due to momentary unbalance, but no damage should result and the author's instrument has never given trouble. The working conditions of the associated transistors virtually preclude a damaging current flow. However, if the constructor wishes to minimise this effect, it can be improved though not eliminated by connecting an 0A90 diode directly across the meter terminals with its cathode to the negative terminal. The meter reactions are then more gentle, but the sensitivity is reduced by some 20pc and linearity is spoiled. The decision rests with the user, but the writer feels it is hardly worthwhile.

The only other points to watch are concerned with noise and stray signal pick-up. A shielded input cable should always be used, allowing two feet or more between signal source and DF Meter, especially in the case of high-powered amplifiers. Watch also for stray AC fields from transformers and especially from filter chokes, also for radiation from TV sets and from Oscilloscope timebases. In some locations radiated interference from the electric wir-

(Continued on page 126)

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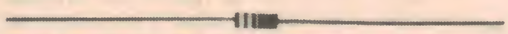

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Circuit & Design Ideas

Conducted by Ian Pogson

Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

Transistor tester checks frequency response

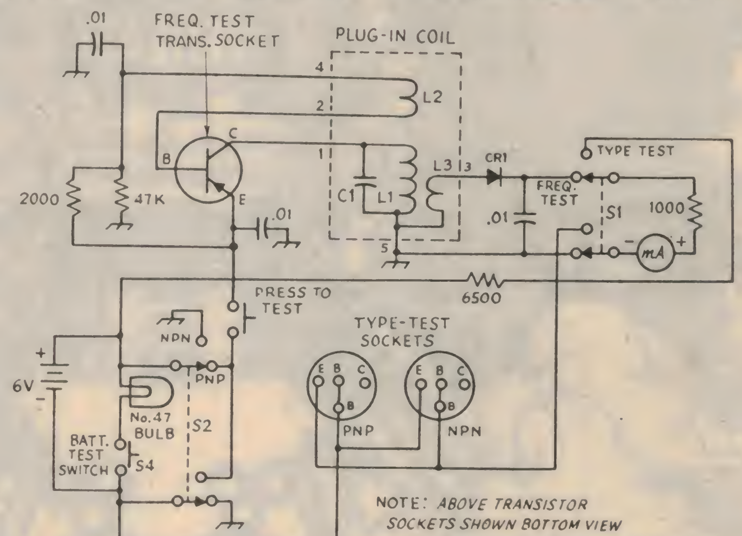
Basically, this new transistor tester will test itself for run-down batteries, determine whether the transistor is an NPN or PNP type and see how high in frequency the unknown transistor can go and still maintain a reasonable current gain.

The circuit shows the battery test feature, which merely taps a No 47, 6V lamp across the battery. Since this lamp draws 150mA (the usual transistor draws far less), you can assume that if the batteries light the lamp to full brilliance, they are live enough to handle the average small transistor. Circuit for transistor type testing operation is based on the fact that the emitter-base junction (or base-collector junction) of a transistor is equivalent to a crystal diode and hence will conduct current in one direction only. Which direction the current flows depends on the transistor type.

The two type-test sockets are connected in parallel with each other and in series with the meter and two current limiting resistors. If a PNP transistor is placed in the NPN socket its emitter-base diode will be in the non-conducting direction and the meter should read zero. Placed in the PNP socket however, the transistor's diode will be in the conducting direction and the meter should show a reading. If you get a transistor that shows a current reading in both sockets, you have a shorted, or at least a leaky transistor.

The circuit for determining the frequency limitations of the transistor amounts to a self-excited oscillator with the frequency being determined by the plug-in coil used. If the transistor is capable of operating on the frequency of that particular plug-in coil it will oscillate. Some of the RF energy will be drawn off by the coil, rectified by the diode and will actuate the meter. I used five plug-in coils, representing frequencies of 1, 3, 12, 31 and 60MHz, respectively.

To check a transistor, set S1 to type-test position and plug the transistor into each of the type-test sockets in turn. To test frequency capability, set S1 to freq test. Set S2 to PNP or NPN, depending on transistor type and plug the transistor into the freq test socket. Plug in the highest frequency coil and press S3. If the meter reads, the transistor is capable of handling 60MHz and probably more. If the meter does not read, continue to use lower frequency coils until one is found that will cause the transistor to oscillate. You now know the approximate frequency limit of that transistor.



Construction of the unit should pose few problems. Keep the freq test transistor socket close to the plug-in coil socket so as to keep short RF leads. It is also a good idea to locate S3 far enough from the coil socket that it can be pressed without getting the hand too close to the coil. Care should also be taken with the tickler-coil windings (L2). If the windings are phased correctly you get positive feedback and oscillation. If phasing is wrong, you get nothing. Make one coil as shown except leave the two ends of L2 unconnected.

Plug in a transistor you know will handle the frequency and temporarily solder the ends of L2 to the pins. Make sure S1 and S2 are positioned properly. Plug the coil in and press S3. If the meter reads, it indicates that L2 is properly connected. If the meter does not read, reverse the two ends of L2 and try again. Once you have one coil wound correctly, just wind the coils on the other formers in the same direction.

(By Howard Hanson, W7MRX, in "QST".)

PLUG-IN COIL DATA

MHz	L1	L2	L3	C1
60	3T	3T	3T	25pF
31	7T	6T	4T	25pF
12	12T	7T	6T	80pF
3	22T	10T	9T	270pF
1	34T	20T	8T	1000pF

All coils close wound on 19mm diameter formers.

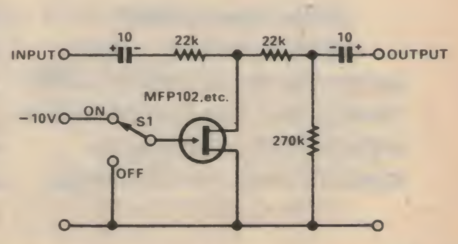
Editorial note: No wire gauge is specified.

Low cost FET switches audio signals

The switch circuit uses an n-channel FET to present either a high or a low impedance earth return path to the signal to be switched. The main advantage of such a system is that it removes the need for audio signals to be fed to switches. The signal switching can occur on a circuit board whilst the mechanical switch handles only DC. This helps reduce hum pickup and other undesirable strays problems.

As may be seen, in the "off" state the FET is biased to conduct heavily, thus effectively shorting the AC signal to earth. Switching the FET to the "on" state biases it into the non-conducting region thus presenting a high impedance across the signal. This allows the AC signal to continue virtually unattenuated.

A large number of these switches can be driven from one DC switch without risk of cross-talk, thus reducing the number of multiple-pole switches needed. In addition, the control voltage could be obtained from logic outputs. Switch performance can be improved if required by biasing the gate slightly positive, about 1V, in the off position. P-channel FETs may be used with suitable reversal of the gate voltage. The two capacitors act as DC blocks to prevent DC appearing at the drain of the FET. The stage following the FET switch should have an impedance in excess of 50k to avoid excess loading.



(By C. G. Louisson, in "Practical Electronics".)


EVEREADY
TRADE MARK
ALKALINE
ENERGIZER
EXTRA
HEAVY DUTY
UNION
CARBIDE

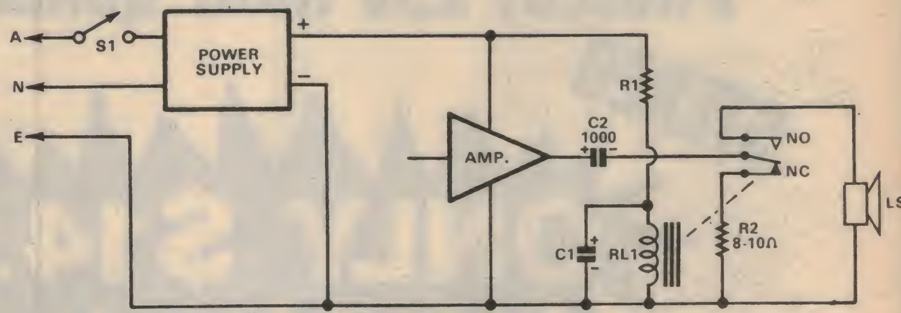
Eliminating amplifier switch-on surge

A number of audio amplifiers suffer from switch-on current surge through the loudspeakers, particularly low impedance speakers. This circuit overcomes the problem by connecting the speakers to the amplifier only after the initial current surge to the output capacitors has occurred.

When the amplifier is initially switched on, C1 starts to charge. At the same time the amplifier output capacitor charges up through R2. When C1 reaches the potential required to operate the relay the contacts are switched over replacing the dummy load R2 with the loudspeaker.

The value of R1 is best found by experiment or can be calculated by dividing the supply voltage by the relay rated current and then subtracting the resistance of the relay coil. C1 should be about 2500uF so as to allow the relay contacts to remain open long enough for the output capacitor to become fully charged. This is normally about 3 to 5 seconds. Only one channel is shown but for stereo the relay would require two sets of contacts.

(By J. Farrimond, in "Practical Electronics".)



Battery current measuring test probe

Here is a device to facilitate measuring current consumption in radio or cassette players, using batteries with spring contact connections.

It is almost impossible to insert test meter probes between the batteries and the contacts as the springs in the holder force them together. To overcome this problem, cut a strip about 10cm long and 7mm wide, of double sided copper clad board, or two strips of single sided board glued together. The copper sides should be thinly tinned to prevent oxidation. When completed the strip is sharpened at one end and can be inserted between the batteries and contacts. The meter probes can now be touched against the sides of the strip and the current read.

(By N. J. Moyes, in "Everyday Electronics".)

Fast printed circuit etching

Here is a simple method for fast printed circuit board etching which I have been using successfully for several years. Instead of the classical ferric chloride solution, I use a mixture of one part hydrochloric acid to three parts 40 per cent hydrogen peroxide. This solution strips the board clean of unprotected copper in less than 30 seconds.

Both chemicals are nasty and should be treated with due respect. Skin contact must be avoided, and the etching should be carried out with all windows open and within close reach of a running tap. The reaction releases a fair amount of heat, which again speeds up the process. A splash of water, though, is all that is needed if the fizzing gets too drastic.

The etching may be carried out in any shallow plastic or glass container. As no sediment is formed, the only agitation required is a gentle rocking of the tray in order to disperse the heat. The solution should be mixed immediately before use, as the peroxide decays fairly quickly once mixed with the acid. The ratio of the ingredients is fairly critical, although too much peroxide works better than too little. It is advisable to test the solution with a bit of scrap board before plunging in one's newly finished masterpiece.

(By J. Langvad, in "Wireless World".)

Square wave oscillator

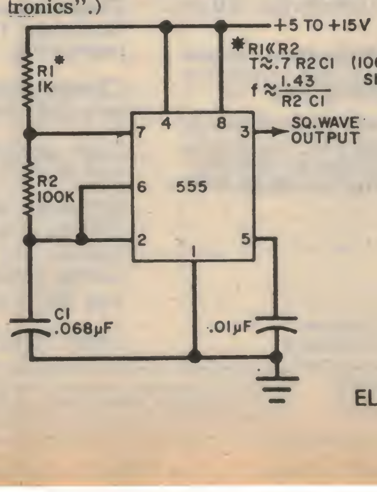
A conventional astable circuit using a 555 IC does not normally produce a symmetrical output waveform. However, square waves can be obtained from a 555 by using the simple circuit shown here.

The symmetry of a conventional astable circuit is a result of the fact that the charging and discharging time constants are not equal. If the timing capacitor can be charged and discharged through the same (or equivalent) resistance value, the symmetry can be restored.

In this circuit, the capacitor C1 is charged through R1 and R2 and it is discharged through R2. If R1 is made very small in resistance compared with R2, then both time constants will be reduced so that they depend essentially on R2 and C1

The frequency of operation of this circuit is approximately equal to 1.43 divided by the product of R2 and C1. The frequency is of course independent of the supply voltage.

(By Walter G. Jung, in "Popular Electronics".)



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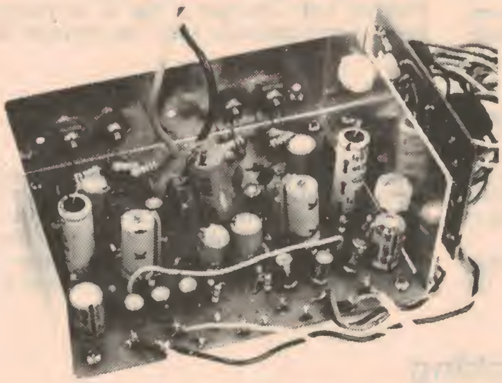

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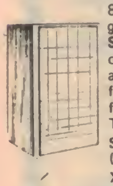

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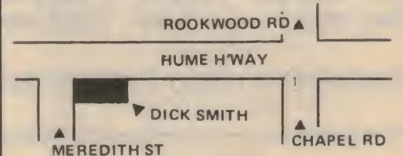

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Colour Television Systems

Transmitting the colour information. Bandwidth problems. The frame sequential system. Development of the NTSC system. Limitations of the human eye. Waste space in the TV channel. The chrominance sub-carrier. Minimising sub-carrier interference. The sub-carrier reference burst. Encoding and decoding the colour signals. Reconstituting the green signal.

In the previous chapter we dealt with the two ends of the colour TV chain; the colour TV camera and the colour TV picture tube. Because of its complexity, we have left the link between these two until last.

When engineers addressed themselves to this part of the problem, they faced a number of formidable obstacles. Superficially, it appeared that any colour system would require three times the channel space of a monochrome system; ie, one channel for each colour.

In fact, such an approach was quite untenable. It would mean that only one TV station could be provided where formerly there were three, to say nothing of the chaos that would be caused by trying to rearrange virtually the whole of the VHF spectrum to allow the chosen station to expand. On top of that, such a system would call for a receiver of prohibitive complexity.

So, in reality, engineers had only two choices; either accept a serious downgrading of picture quality or find some way to transmit the required information within the existing monochrome TV band.

Many ideas were put forward and at least one, the Columbia Broadcasting System (CBS) frame sequential system, was given brief approval by the US Federal Communications Commission (FCC) as a standard system.

This system was mentioned briefly in the chapter on colour mixing. It simply transmitted each field in one of the three primary colours. The image was presented on a conventional monochrome picture tube and viewed through a colour wheel which rotated in front of it. The wheel was driven by a motor synchronsied with the incoming signal.

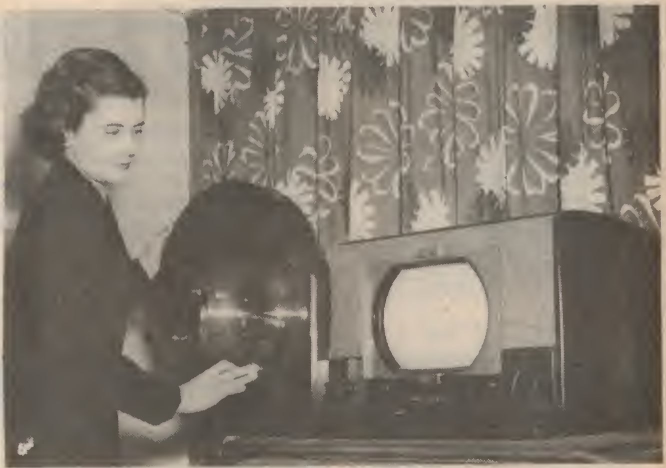
Superficially, the field sequential system might appear to overcome the bandwidth problem, being the kind of thing that could be simply "tacked on" to the existing black and white system. In fact, it was not as simple as this. While the field rate of 60 per second was adequate to portray movement and avoid flicker in the black and white system, it was not adequate when any one colour was presented at only one third this rate. Areas predominantly in one colour created serious flicker problems, while moving objects tended to break up into three separate coloured images.

To overcome this the field rate had to be increased. But to do this would increase the bandwidth, unless something else could be sacrificed. The final compromise was an increase in field rate from 60 to 144, and a decrease in picture detail from 525 lines to 405 lines. By these means the system was kept just within the 6MHz bandwidth allocated to US TV stations.

But the system still had serious limitations. One of the most serious was the physical size of the colour wheel, which for any picture tube above 300mm diagonal became prohibitively large. Another was that the change in standards rendered the transmissions non-compatible with existing receivers. And, in spite of the increased picture rate, there was still colour break up on rapidly moving objects, as in sporting events.

Meanwhile, the rest of the industry, and RCA in particular, were convinced that a mechanical system was not only unsuitable for home use, but unnecessary. They were working towards this end and believed that a fully electronic system was practical.

CBS demonstrated their system in July 1949 and, in spite of the inherent limitations, the demonstration was impressive. At this time the FCC announced that it would conduct a hearing later in the year to select a colour system. The industry in general, and RCA in particular, while still convinced that an all electronic compatible system was practical, needed more time to develop it.



A colour receiver for the CBS field sequential system. The rotating colour disc is housed in the unit on the left, which has been moved to one side to permit black and white reception. It was necessary to fit a standards converter for this latter purpose.

Between July and October 1949 RCA made a massive effort to produce a system in time for the hearing. The effort was described at the time as ". . . an exhausting ordeal during which they were subjected to heavier pressure than any industrial research group had ever known in peacetime."

At the hearing RCA demonstrated a compatible, 6MHz, high definition system, but had to display the pictures via a three tube projection system. It advised the FCC that it would have direct viewing tube ready within six months. Along with the rest of the industry, they pleaded for more time to develop the all electronic system.

In spite of this, the FCC accepted the CBS system, with the proviso that it would reconsider the decision if an acceptable system could be demonstrated. RCA delayed the introduction of the CBS system by appealing to the Supreme Court. In May 1951 the Court ruled the decision valid and CBS began colour transmissions in June 1951.

But the legal proceedings had bought vital time for RCA. Continuing their "massive effort" they completed their work on the colour tube and improved other aspects of the system. By July 1951, only one month after CBS commenced transmissions, RCA was able to demonstrate a fully compatible, all electronic colour system, using their tri-colour shadow mask tube. The demonstration was hailed by the press as the best that had been shown, and a vast improvement on the CBS system.

Shortly after this CBS ceased transmissions, partly due to a shortage of materials with which to manufacture colour receivers (the US was then involved in the Korean conflict), and these were never resumed. Meanwhile, the rest of the industry formed the National Television Systems Committee (NTSC) to present a case for an all electronic system to the FCC. It took two years to iron out remaining technical problems and produce the necessary standards, and the FCC finally approved these standards on December 17, 1953. Thus the NTSC system was born.

One product of RCA's "massive effort" was the shadow mask picture tube, the main credit for which is given to Harold B. Law, of RCA. (The details of this tube were discussed in the previous chapter.) The other achievement was fitting the "quart' of bandwidth into the "pint pot" of spec-

trum space.

They were able to do this by establishing and exploiting two important facts. One was enunciated by A. V. Bedford of RCA, to the effect that the visual acuity of the human eye is relatively poor in colour; much lower than it is in black and white. As a result, he suggested a system which transmitted a standard high definition black and white image, plus a relatively narrow band colour signal which would produce a low definition colour image effectively superimposed on the high definition black and white image.

Practical tests confirmed this theory, bringing the ultimate solution significantly closer. But it was not a complete solution. Space still had to be found to transmit this information, limited though it was, within the existing 6MHz band.

Energy distribution in the colour TV carrier. Luminance information appears either side of the video carrier, in clusters at harmonics of the horizontal frequency (fh). Chrominance information appears in clusters either side of the colour subcarrier (fsc), also separated by harmonics of fh, but falling in between the luminance clusters.

The solution to this was suggested by Frank Gray, of the Bell Telephone Laboratories. He pointed out that the space occupied by a TV channel was not fully utilised; that there was a good deal of waste space in which another signal might be interleaved.

His analysis of the video signal energy distribution within a TV channel revealed that maximum energy occurs in clusters at each harmonic of the line frequency (15,734Hz in the US). Further, each of these clusters exhibits peak energy at the line harmonic, tapering off either side with progressively lesser energy peaks separated by harmonics of the picture and field frequencies (30Hz and 60Hz in the US).

Between these clusters are points of minimum energy, the actual energy depending on the picture content. In practice this was normally so small that it appeared practical to locate other, narrow band, energy clusters at these points without overloading the modulation capability of the transmitter.

This, then, was the basis on which the NTSC system finally evolved. It has remained virtually unchanged and its basic principles have been exploited, with variations, to produce the PAL and SECAM systems.

The colour, or "chrominance," information is impressed on a chrominance subcarrier, the frequency of which is carefully chosen to satisfy a number of requirements. The first is to ensure that the chrominance information interleaves the existing video, or "luminance," information in the manner already described.

This is achieved by making the subcarrier frequency equal to an odd harmonic of half the line frequency; a technique known as "a half line offset." The actual harmonic chosen is dictated by a number of other requirements.

Most of these are aimed at minimising interference to the picture; something which is inevitable when an extra channel is included in the video band. In fact, it produces a dot pattern, consisting of alternate light and dark areas along each line. The important thing is to ensure that this is not so obvious as to distract the viewer.

The first thing is to keep the subcarrier frequency as high as possible, thus making the dot pattern as fine as possible. Fairly obviously, it cannot be higher than the maximum video frequency and, in fact, it must be lower than this by an amount necessary to accommodate the sidebands which will occur either side of it.

Another trick is to ensure that the number of subcarrier half cycles, per line, is an odd number. This causes the light areas on one line to fall directly alongside the dark areas on an adjacent line. Thus, at a viewing distance which does not permit resolution of individual lines, the light areas on one line tend to cancel the dark areas on the adjacent line.

In the NTSC system the outcome of these requirements is that the colour subcarrier is at the 455th harmonic of half the line frequency, or 3.57945MHz. The quotation of this value in such precise terms is deliberate and implies a high order of accuracy which, in fact, is essential. In general discussion these figures are often rounded off to three significant figures, but the accuracy involved is still understood.

Other TV systems, employing different line and field frequencies and/or other colour systems, employ other subcarriers. For example, the PAL system, as used by most European countries with a 625 line standard, employs a subcarrier of 4.43361875MHz. This applies also to the Australian system.

The final step in minimising interference is not to transmit the actual subcarrier at all, only the sidebands generated by modulating it. The end result is a fine dot pattern in parts of the picture only, which while it can be seen on close inspection, is not normally visible at a normal viewing distance.

The manner in which the subcarrier is used is just as ingenious as the manner in which it is accommodated. Three characteristics have to be transmitted in order to create a colour picture: luminance, hue, and saturation. The luminance information is already contained in the normal black and white video signal, leaving hue and saturation still to be transmitted. The hue is transmitted as phase modulation and the saturation as amplitude modulation of the subcarrier.

As already noted, the subcarrier itself is not transmitted, only the sidebands. While this is essential to keep interference to a minimum, it does make recovery of the colour information at the receiver just that much more complex. Without a carrier there is no reference against which either the phase or amplitude of the sidebands can be compared. Therefore, an artificial carrier must be generated at the receiver.

This carrier must have an extremely high order of accuracy. It is not sufficient that it have exactly the same frequency as the original subcarrier, though this alone would be a formidable requirement, even for a crystal controlled oscillator. In this case it must also have exactly the same phase as the original subcarrier.

Since a self contained oscillator with this order of performance is a virtual impossibility, and in any case could not allow for marginal drift which might occur at the transmitter, some means must be found to lock the receiver's oscillator to the transmitter's subcarrier generator.

The way in which this is done is also very ingenious. The receiver oscillator is made as stable as possible using standard techniques—eg, crystal control—so that it has good short term stability. Also, its associated circuitry is so arranged that it can be readily "pulled" into step with a reference frequency.

A reference frequency from the subcarrier generator is transmitted very briefly at the end of every line, during the line blanking period. More precisely, it consists of between eight and 10 cycles of subcarrier, superimposed on the "back porch" of the line synchronising pulse. This is known as "the reference burst" or, more commonly, "the burst". (The back porch is the period immediately following the sync pulse, but before the commencement of video information, when the carrier is at approximately black level.)

Suitable circuits in the receiver extract this burst and feed it to the reference oscillator circuit. Here is is compared with the reference oscillator and, if the phase of the latter is incorrect, correction is applied. The oscillator will normally be stable enough to maintain this phase during the ensuing line period (around 60 microseconds) and any small drift tendency will be corrected again before the next line.

Thus, in a transmitted colour TV signal at any instant there is a luminance signal (normal black and white signal), plus a chrominance signal with a particular phase to indicate hue, and a particular amplitude to indicate the saturation of that hue. There is also a 10 cycle reference burst of the otherwise suppressed colour subcarrier, superimposed on the back porch of each line synchronising pulse.

In the discussions which follow, plus those which the reader will encounter in other texts, this "end product" should be continually kept in mind. It is very easily lost sight of in the necessarily detailed discussions involving the encoding and decoding of the colour information. But remember, this is the final form which the transmission takes.

Having said that, let us look at the encoding and decoding process. We have already discussed the colour camera in the

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last chapter, and how it is made to deliver three signals representing the three primary colours — red, green and blue — plus a fourth signal, the luminance signal, which is a mixture in suitable proportions of the red, green and blue signals. It is the luminance signal which provides the high definition image for either a black and white or colour picture. In colour TV terminology it is designated as the "Y" signal. The colour signals are designated "R" (red), "B" (blue) and "G" (green).

To produce the Y signal R, B and G signals are mixed in proportions dictated by the sensitivity of the human eye. This is most sensitive to green, less sensitive to red and least sensitive to blue. More precisely, the proportion is .59G, .30R, .11B, on the basis that the total Y signal is equal to 1. It is important to keep these proportions in mind when studying the encoding system to be described later.

In fact, it is convenient to think of these figures as signal voltages; a Y signal of 1V being composed of 0.59V G, 0.30V R, and 0.11V B. The Y signal is used to modulate the transmitter in the normal way, but is also fed into matrix circuits where it is mixed with two of the colour signals to produce modulating signals for the colour subcarrier.

The two signals used are the blue and the red, these being taken off before the mixing network which produces the Y signal. Thus each is at the same level as the Y signal, ie, 1V. The Y signal is first inverted and then subtracted from the blue signal to produce a B-Y signal, and the red signal to produce an R-Y signal. These are known as colour difference signals.

Modulation of the subcarrier involves, initially, two subcarriers, both of the same frequency, but one shifted in phase from the other by exactly 90 degrees. The B-Y signal modulates one, the R-Y signal the other. (The green signal is not forgotten. Because it forms part of the Y signal, it can be extracted at the receiver.)

The two subcarriers are basically amplitude modulated, with one qualification. As we shall see, both the B-Y and R-Y signals can carry either a positive or negative sign. This is accommodated by shifting the subcarrier phase through exactly 180 degrees. At this point the two subcarriers are combined, producing a single phase and single amplitude which are each the product of the two phases and two amplitudes. This is the "end product," mentioned earlier, which is transmitted.

At the receiver the two original subcarriers are re-constituted. This is not difficult because, although they were combined into a single subcarrier, we know the manner in which they were combined. At the receiver we generate two artificial carriers, one exactly in step with the reference burst, and one exactly 90 degrees out of phase with it. By mixing the chrominance signal with each we reconstitute the original B-Y and R-Y signals exactly as they were when used to modulate the original sub-carriers.

Thus, at the receiver, we have the original Y signal, plus the B-Y and R-Y signals, exactly as they came from the encoder at the transmitter.

At this point let us consider a number of likely colour situations, how they would modulate the subcarrier, and how we reclaim the colours at the receiving end. This situation is portrayed pictorially in Figs. 1 to 4 which should be studied closely in conjunction with the text.

These diagrams portray the encoding system on the left and the decoding system on the right. In between would be the transmitter and the receiver. For simplicity, we are assuming that these links are perfect and that the input to the decoder is identical in all respects with the output from the encoder. The output from the decoder, ie, the blue, green and red signals, would be fed, after suitable amplification, to the grids of the blue, green and red guns of the picture tube.

First, consider a pure red signal. The Y signal will come from the red signal only, equal to 0.30V or, after inversion, -0.30V. The full red signal will be 1V, making the R-Y signal 0.70V. There will be no blue output, so that B-Y will be -0.30V.

At the receiver, we reclaim the red signal by adding the R-Y signal to the Y signal. Assuming the original voltage relationships have been maintained throughout the link, the same values may be quoted at the receiver end for purposes of explanation. Thus we have a Y signal of 0.30V added to the R-Y signal of 0.70V; a total of 1V, or exactly what was delivered by the red channel originally. Fed to the grid of the red gun, after amplification, it would activate the red phosphor on the screen and produce a red image.

At the same time we add the B-Y signal to the Y signal. The B-Y was -0.30V and Y was 0.30V; a total of zero, or exactly what was delivered by the blue channel.

Now let us consider a pure blue signal (Fig. 2). The Y signal will come from the blue signal only, equal to 0.11V or, after inversion, -0.11V. The full blue signal will be

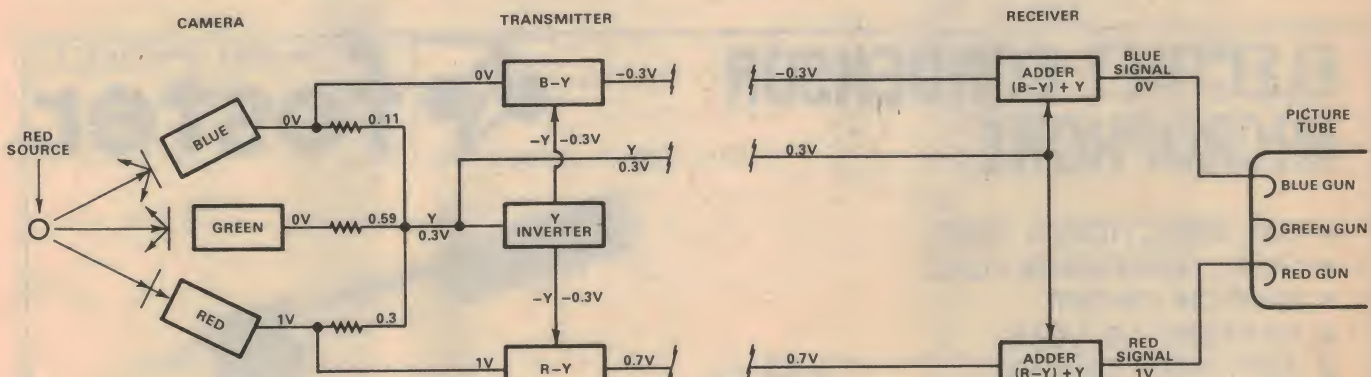


FIG. 1

Fig. 1. Encoding and decoding the colour information for a pure red signal. Addition of the Y and B-Y signal in the decoder produces zero volts in the blue channel, while addition of the Y and R-Y produces 1V in the red channel; the same values as fed to the decoder.

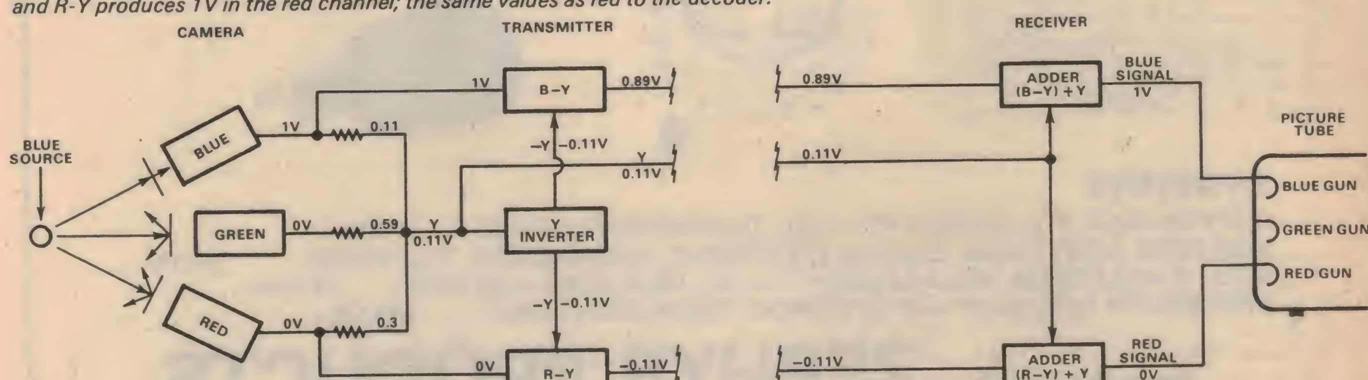


FIG. 2

Fig. 2. Encoding and decoding the colour information for a pure blue signal. Addition of the Y and R-Y signals in the decoder produces zero volts in the red channel, while addition of the Y and B-Y produces 1V in the blue channel; the same values as fed to the encoder.

1V, making the R-Y signal 0.89V. There will be no red output, so that R-Y will be -0.11V.

At the receiver we reclaim the blue signal by adding the B-Y to Y. Thus we have a Y signal of 0.11V added to the B-Y of 0.89V; a total of 1V, or exactly what was delivered by the blue channel originally. Fed to the blue gun it would produce a blue image.

At the same time we add the R-Y signal to the Y signal. The R-Y was -0.11V and Y was 0.11V; a total of zero, or exactly what was delivered by the red channel.

The decoding process for a pure green signal is shown in detail in Fig. 3, which includes a number of additions to the decoder system. As before, the Y signal will come from one channel only, this time the green. It will be equal to 0.59V or, after inversion, -0.59V. With no output from either the blue or red channel, B-Y and R-Y will both be -0.59V.

At the receiver, B-Y will be added to Y, producing 0V, as delivered by the blue channel originally. Similarly R-Y plus Y gives 0V for the red channel, which is again correct.

Now comes the tricky part. We need a G-Y signal to add to the 0.59V Y signal to bring it up to the original 1V from the green channel at the transmitter. Fairly obviously this G-Y signal should be 0.41V.

In fact a G-Y signal is obtained by taking suitable proportions of the B-Y and R-Y signals, adding them, and inverting. More precisely, we take 0.186 of the B-Y signal and 0.51 of the R-Y signal. In this case B-Y is -0.59 which, multiplied by 0.186, gives -0.11. Similarly, R-Y is -0.59 which, multiplied by 0.51, gives -0.30. The sum of -0.11 and -0.30 is -0.41 which inverted, becomes 0.41, the voltage we require for the G-Y signal. This is now added to the Y signal (0.59V) to produce the original 1V generated by the green channel. Via the green gun, it would produce a green image.

The proportions of B-Y and R-Y which are used to construct the G-Y signal are quite critical. The example just presented is a somewhat idealised one, chosen to make explanation easier, in which there is only a fully saturated green signal to be considered. Under these conditions almost any proportions of B-Y and R-Y might have been used to produce the 0.41V needed as a G-Y signal.

But it is not sufficient to produce a green signal when green only is present. Just as important is the requirement that a false green signal is not created in the presence of either or both of the other two colours. The proportions of B-Y and R-Y selected to make the G-Y signal have been chosen on a precise mathematical basis so that this can never happen. As an example, let us go back and see what happens in the case of a pure red signal, now that we have the green matrix fitted.

We have already shown that an encoded red signal consists of 0.30V Y signal, -0.30V B-Y signal, and 0.70V R-Y signal. The -0.30V B-Y signal, when multiplied by 0.186 in the green matrix, becomes -056V. The 0.70V R-Y signal, when multiplied by 0.51 in the green matrix, becomes 0.356. The sum of 0.356 and .056 is 0.30. Inverted, this becomes -0.30V out of the green matrix, and this, when added to the 0.30 Y signal, produces a total of 0 for the green signal, which is correct.

The same reasoning will apply for the pure blue signal condition, and the reader may care to work this one out for himself, as an exercise.

Finally, let us consider a pure white signal (Fig. 4). The Y output will be 1V, which is inverted to -1V. The blue output will be 1V also, so B-Y will be 0. Similarly, the red output will be 1V which, when added to -Y, will also be zero. Thus, neither subcarrier will be modulated and only a Y signal transmitted. (Close study of a colour TV picture will reveal that there is no colour subcarrier pattern on a white image.)

At the receiver the Y signal (1V) is added to B-Y (0V) to produce a blue signal of 1V. Similarly, Y plus R-Y produces a red signal of 1V. And since B-Y and R-Y are both 0V there is no signal fed to the green matrix so that G-Y is also 0V. Thus Y plus G-Y is also 1V.

With signals fed to all three guns all three phosphors on the screen will be activated and combine, optically, to produce white.

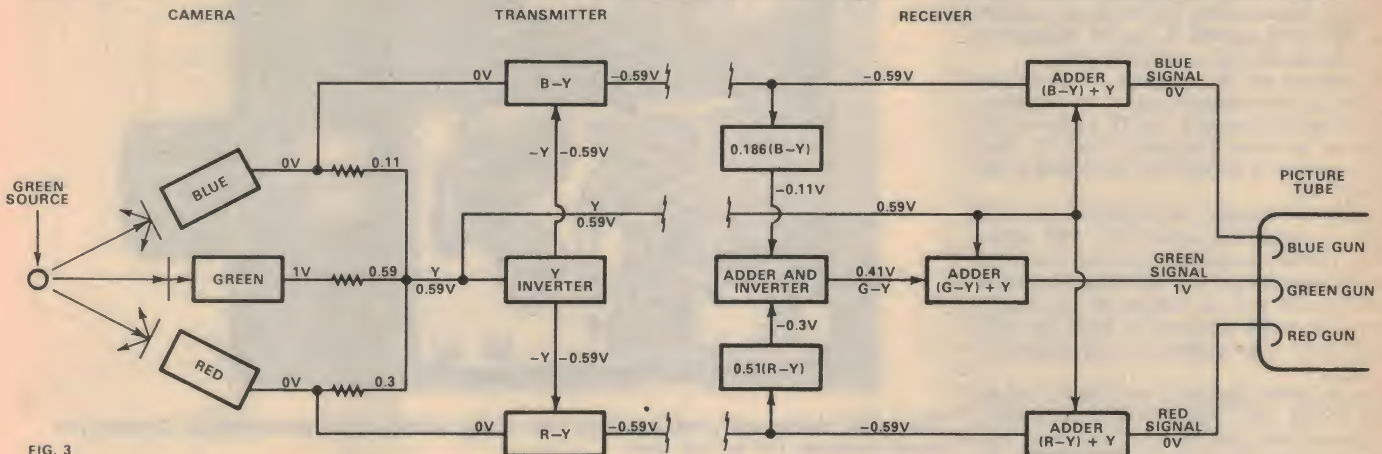


FIG. 3

Fig. 3. Decoding the green signal. The presence of a green signal is deduced from what is happening — or not happening — to the other two channels relative to the Y signal. A Y signal in the absence of red and blue signals can come only from the green channel.

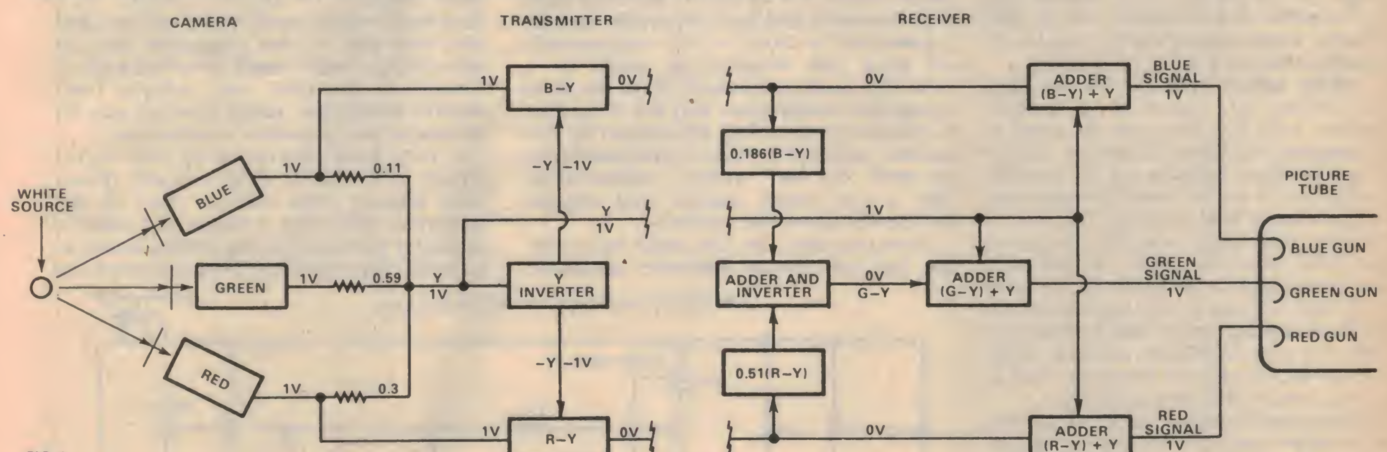


FIG. 4

Fig 4. The white signal. In this case there is neither a B-Y, R-Y, or G-Y signal; only a Y signal. (Compare this with the green signal in Fig. 3.) With no "minus Y" signals fed to any of the adder networks, the Y signal appears at each colour channel output.

The "Minispot" — 455kHz Test Oscillator

Elementary Electronics

by Ross Tester

Many readers have an adequate collection of tools, but when it comes to test equipment, most draw a blank. Here is one device which won't break the bank — but will be handy for anyone who builds radio receivers.

We have published the Minispot before, back in September 1970, but, after nearly four years we feel many readers — particularly Elementary Electronics readers — would have missed it. So we dragged it out of the mothballs — and here it is.

Alignment of IF systems is aimed at satisfying two requirements: (a) ensuring that all tuned circuits in the IF systems are tuned to the same frequency and (b) that the frequency to which they are tuned is the correct one.

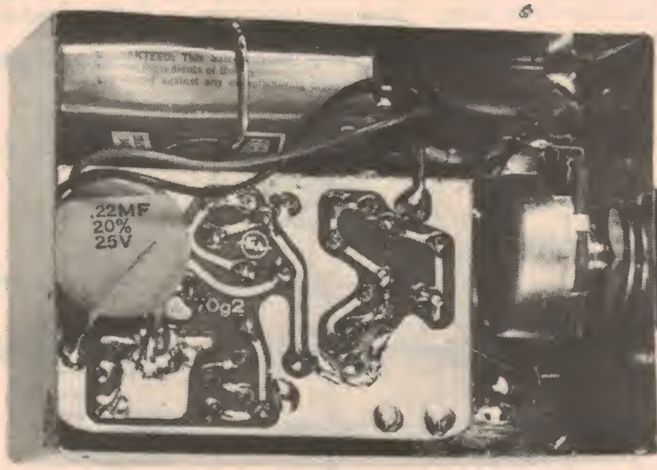
Failure to satisfy requirement (a) will result in degraded sensitivity and selectivity. Failure to satisfy (b) can result in spurious heterodynes or whistles in certain localities, as well as failure of the tuning system to track accurately with the dial calibrations, particularly in the centre of the dial.

The simplest approach to receiver alignment is "by ear." Using broadcast signals at appropriate positions on the band, the various tuned circuits are adjusted to produce maximum output from the loudspeaker. While this approach has the advantage of simplicity, will undoubtedly result in some improvement, and is thus justifiable when nothing better can be attempted, it leaves a lot to be desired.

It cannot ensure that the IF system's tuned circuits are tuned to a specific frequency, only that they are all tuned to approximately the same frequency. This is only approximate, because we are depending on the ear to tell us when the maximum signal level has been reached. The ear is notoriously insensitive to small changes in signal level (less than 3dB) so that each adjustment could conceivably be in error by, say, 2dB. If there are six adjustments to make there is room for a possible total error of 12dB — a very significant amount. While the error will usually be less than this in practice, it may still be significant.

The more usual approach calls for the use of an oscillator (or signal generator) and an output meter. The generator should be capable of generating RF signals, suitably modulated, at the IF used by the receiver, at frequencies at each end of the broadcast band, and in similar positions on the shortwave band or bands, where these are featured.

In use, the generator is connected so as to feed signals into the appropriate part of the receiver, while the output meter is connected to the output circuit feeding the loudspeaker. The generator is modulated with a steady tone — rather than music or speech as from a broadcast station — and this is registered as a fixed level on the output meter. As various adjstments are optimised (peaked), the meter will swing up the scale to maximum reading, giving a far more accurate indication than can the ear.

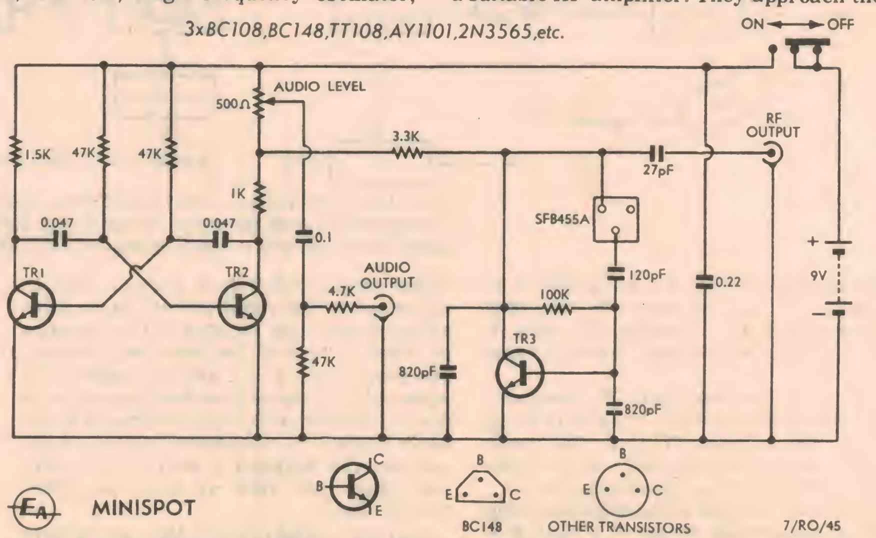


This inside photograph gives a general idea of the position of all components. Connect the board common foil to the case.

While most multimeters can serve as an output meter, it is the generator which most experimenters find hard to provide. Indeed, a generator to satisfy all the requirements we have just enumerated would be a relatively costly instrument. However, if we accept the compromise that the IF system is the one most needing adjustment by this method, and that the other adjustments can be made "by ear" without serious error, then a very much simpler and cheaper device will serve our purpose.

More precisely, we can settle for a simple, low cost, single frequency oscillator, preset to the popular 455KHz IF, and intended to do no more than provide alignment facilities for the IF channel. Such devices have been marketed in the past, and also described in this magazine, but the older designs were based on valves and LC circuits. In this form they suffered from certain limitations, many of which can be overcome using modern components.

A very good alternative to the old LC circuit is a ceramic filter element. These have already been used in some of our receivers, and make a cheap and reliable oscillator when used in the feedback loop of a suitable HF amplifier. They approach the



The circuit of the Minispot oscillator. Simplicity has been achieved by using a ceramic filter oscillator modulated by a multivibrator.

stability of a crystal, and would be much more accurate than a preset LC circuit or even the conventional service oscillator, when one considers the problems of accurately setting a simple dial.

To understand more fully the operation of the ceramic filter as a resonant element in an oscillator we refer those readers interested in the subject to two back issues, September and October, 1969, where a full treatment of ceramic filters is given.

We have based our design on the first circuit discussed in the October, 1969 issue. One advantage of this arrangement, among others, is that it has quite a high RF output; a useful feature where we may wish to penetrate grossly mistuned circuits as may be encountered in a freshly constructed receiver.

The circuit is also quite easy to modulate. The modulating tone is generated by a free-running bistable multi-vibrator operating in the vicinity of 500Hz. This also provides an audio signal source in addition to the RF source. It modulates the RF oscillator by varying the supply voltage fed from the junction of the two resistors forming the collector load of one of the multivibrator transistors. The two resistors function as a voltage divider to control the depth of modulation.

A convenient level control for the audio output can be provoided by substituting a potentiometer for a portion of the collector load resistor of TR2.

No problems should be encountered in housing the device. Any small metal box such as a throat tablet or tobacco tin would suffice, providing that there is sufficient space to house all the necessary components. We made a box from tinplate extracted from a large coffee tin, using a pair of tinsnips and a soldering iron. A metal housing must be used to prevent direct radiation from the multivibrator, as the harmonic content generated by the fast-rise edges is sufficient to couple into the audio stages of a receiver.

Construction is based on a small printed board, coded 72/g7. All components except the potentiometer, output capacitor, and audio output components are mounted on this board. The latter components are mounted between the board and the sockets etc. The on-off switch (a slider type) is also mounted on the board — or, rather, the printed board is mounted on the switch.

The switch lugs are long enough to protrude through the circuit board before soldering, and at the same time, allow sufficient height for installation of the tallest components. If BC148 Lockfit transistors are not used, the alternative types should be kept low enough on the circuit board to prevent them fouling when the assembly is mounted. Metal encapsulated types almost invariably have the collector connected to the envelope, and if these touch the inside of the metal case, the unit will not function.

The whole assembly is then mounted in the box by the switch, along with the two phono connectors, the potentiometer, and the small 9-volt battery. The assembly of these components should be self-explanatory from the photographs. To complete the shielding, the back cover can be spot soldered on opposite sides to ensure electrical contact.

The output connecting lead can be made from two pieces of ordinary hookup wire soldered into a phono connector, and provided with two crocodile clips on the opposite ends. Avoid the use of screened or coaxial cable, as the extra capacitance will reduce the available RF output, and degrade the rise time of the audio waveform from the multivibrator.

The Minispot can be used to align the IF amplifier section of receivers equipped with 455KHz IFs, whether valve or solid state, with or without a ferrite antenna. There are several established ways in which RF can be coupled into a receiver, and a very full treatment of alignment principles has been discussed at length in a previous issue of this magazine. Copies of this article can be obtained for 80c each (Aligning a Superhet Receiver; File No. 8/C/10, Oct, 1964.)

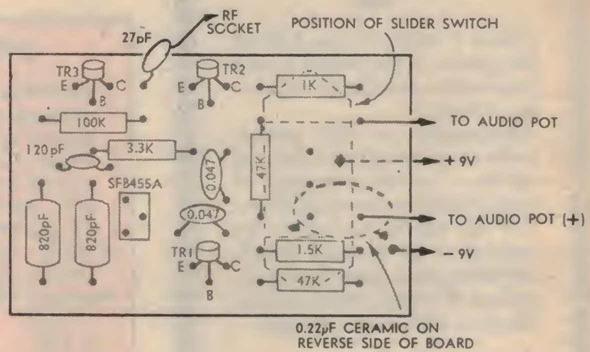
In the case of a valve receiver, the most common input point is the grid of the mixer valve. In the case of solid state receivers the base of the mixer, or mixer-oscillator, stage is the logical equivalent. When either of these arrangements are used, the tuning capacitor should be set for minimum capacitance to avoid any undue loading on the generator signal.

At the mixer input, coupling can be made through a twisted pair of insulated wires, the amount of wire and twisting controlling the capacity (and hence the RF level) between them. The RF level can be reduced by simply unwinding the twisted pair.

In any alignment procedure, the presence of an AGC (Automatic Gain Control) system presents a minor problem. Virtually all sets are fitted with AGC systems, the purpose being to maintain, as nearly as possible, a constant audio output regardless of whether the received signal is weak or strong. This they do very well (though not perfectly) but, fairly obviously, this action is undesirable during alignment, since it tends to mask the effectiveness of each adjustment as it is made.

Fortunately, most AGC systems are deliberately designed to have a threshold level below which they do not operate. (Delayed AGC.) This is to ensure maximum sensitivity to weak signals. We can take advantage of this during alignment, by deliberately keeping the input from the

X-ray view of the printed board layout from the component side. The 0.22uF capacitor should be soldered with leads as short as possible. Keep metal capped transistors as low as possible for proper clearance from other parts.



generator at the lowest possible level, at the same time keeping the gain of the receiver at the highest level. As various adjustments increase the sensitivity of the receiver, the input should be reduced by a like amount.

Almost any multimeter having the usual AC ranges can be used as an output meter. Some multimeters have special input terminals for this function. A popular point of connection in valve receivers is between the plate of the output valve and chassis. Since there is both AC (signal) and DC voltages present here, an isolating capacitor is used to ensure that only the AC signal is fed to the meter. If this is not provided within the meter it must be provided externally. A value of 0.1uF is common, but is not critical.

The same approach could be used with some transistor output stages, particularly where an output transformer is used. Since most transistor output stages employ push-pull circuitry, connection from collector to collector is often more appropriate. The isolating capacitor should be retained.

A more convenient place from which output signals may be taken is the speaker voice coil circuit. Unfortunately, due to the much lower impedance in this part of the circuit, the voltage is also lower, and may not be adequate in some circumstances. If necessary, a second speaker transformer, connected backwards, can be used to step up the voltage to a more convenient level.

With the Minispot connected to the receiver, adjust each IF transformer core for maximum indication on the output meter, reducing the RF input level as necessary for the reasons outlined previously. The cores should be adjusted so that their physical positions are at the outside of each coil in the IF transformers, NOT towards the inner area through the coils.

All the foregoing methods of connection have assumed that the user has ready access to any part of the receiver; a situation which would normally apply where a receiver had just been constructed but not yet fitted to its case. However, if we wish to work on a complete receiver, it may not be convenient to remove it from its case.

As already discussed, the output meter can probably be connected to the voice coil circuit, which is usually accessible. However, the input to the mixer stage may not always be so easy to get at, particularly in very small receivers. In this case it is

PARTS LIST

3 BC108 or other general purpose NPN transistors
1 Murata ceramic filter SFB455A
2 Phono ("RCA") sockets and plugs
1 printed board, 72 / g7
1 MSP type 70 slider switch
1 9V battery, type 216 with connector
Suitable housing, small knob, wire, screws, crocodile clips, etc.

Resistors (½ W 10pc)

1 100k	1 3.3k
3 47k	1 1.5k
1 4.7k	1 1k

1 500 ohm log potentiometer

Capacitors
1 0.22uF ceramic
2 0.047uF ceramic
1 0.1uF ceramic
2 820pF styro or poly
1 120pF NPO ceramic or poly
1 27pF NPO ceramic

Elementary Electronics Ideas Worth Trying

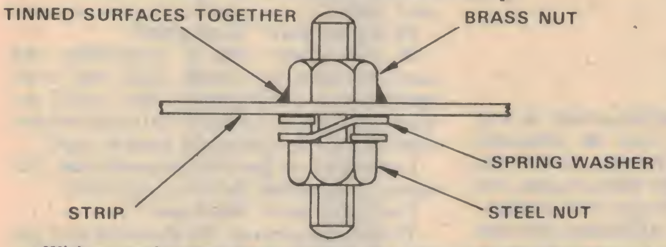
Soldering Hint

It is sometimes necessary to fit an adjustable screw to materials such as springy brass strip. Invariably, the metal to which the screw is to be fitted is too thin to be tapped, and it becomes necessary to solder a nut to it. The problem then arises of suitably positioning the nut and of ensuring that a reliable solder joint is made.

The accompanying diagram shows a scheme which the author has found to work very satisfactorily.

First drill a clearance hole in the thin metal, to suit the screw which is to fit the nut. Then tin around the hole using resin cored solder.

Next, select a brass nut to be soldered to the strip and similarly tin the surface which is to be in contact with the strip.



With a steel screw fix the nut to the strip with the two tinned surfaces together, as illustrated. Fitted on the opposite side of the strip are a steel nut and a steel spring washer. Tighten the nuts so that the washer is compressed.

Apply a soldering iron to the brass nut. The solder on the two tinned surfaces will then melt and the spring washer will force them together. Allow the assembly to cool and then remove the steel bolt, the steel spring washer and the steel nut. The brass nut will now be firmly soldered to the strip.

This method relies on the facts that a small amount of flux still remains on a surface which has been tinned with resin cored solder and that the solder does not readily form a joint with the steel parts which are temporarily used to hold the brass nut in position on the strip.

(This article originally submitted to "Radio and Electronics Constructor" by W. J. Gadsby.)

The "Minispot"

usually possible to feed the signal in through the aerial terminal, where fitted, or by coupling to the ferrite rod antenna.

The Minispot can be coupled to a ferrite antenna either by laying its output lead across the coil on the rod, or forming an induction loop by connecting the two clips on the output leads together. The lead or loop should be spaced away from the rod so as to control the output as mentioned earlier.

The Minispot can also be used as a signal injector. As you may remember, the heart of the signal injector we described last June was a multivibrator — and there is a multivibrator in the Minispot. Because a multivibrator produces near square waves, they are rich in harmonics — making them suitable for troubleshooting in almost any audio or RF circuit.

Both types of circuit are treated in the same manner — you start at the speeaker and work backwards, until you find the stage which is dead. With an audio amplifier, you should notice the strength of tone increasing dramatically particularly as you approach the preamplifier stages. Keep one handy ready to turn the wick down if you don't want to shatter your eardrums!

Much the same behaviour would be expected when working from the detector of a receiver back towards the aerial, but the increases in gain may not be so apparent. While each stage provides amplification, it also provides selectivity which chops off the sides of our very broad signal. Experience with circuits which are known to be working correctly will provide a good basis for comparison.

For more information on using a signal injector, refer to the issue just mentioned — June 1973. All comments which were made then still apply.

Forum

Conducted by Neville Williams

A practical stereo balance meter — or is it?

Wishing to be helpful, a reader from Geelong has forwarded to us an article from an overseas magazine on the subject of stereo balance. It suggests how a stereo balance indicator could be made, thereby casting doubt upon our remarks on the subject in the March issue.

As you may remember, discussion of the subject arose out of a letter from a West Australian reader, who prompted us to remark that some listeners seemed to get altogether too uptight about stereo balance. Perhaps it indicated an undue preoccupation with the amplifier controls generally which, in turn, fostered the situation where, the more you fiddled, the more you needed to!

Such preoccupation often led to a demand for some kind of a meter which would display balance visually and permit the balance control to be set precisely.

We rejected this idea, in the March article, on the grounds that it was based on a wrong assumption: ". . . that the content of the respective channels is similar and therefore capable of precise electrical balance."

But this problem is not seen as a deterrent by a contributor to the particular overseas magazine. The author shows how a stereo balance indicator can be put together using a metal box, sundry bits and pieces and a centre zero meter. You connect it to the respective output circuits of a stereo amplifier and adjust the balance control until the meter pointer remains stationary while the amplifier does its stuff.

Minimum deflection means that there is a minimum difference between the two signals — which means that they are effectively balanced.

The writer claims that a single meter pointer dependent on "difference" is much easier to monitor than two separate pointers bobbing back and forth across their respective scales. He says: "it records the difference between the two channels. If the left channel is stronger than the right, the meter swings to the left. If the right channel is stronger, the needle moves the opposite way."

Fair enough, but that's as far as we can go along with him.

If precise balance is to be expected and achieved, it would be essential to have a mono record on the turntable, but to play it in stereo mode. That way, the entire stereo chain would be operative but the energy fed to the stylus would be as balanced as it is ever likely to be. Electrical balance could theoretically be achieved.

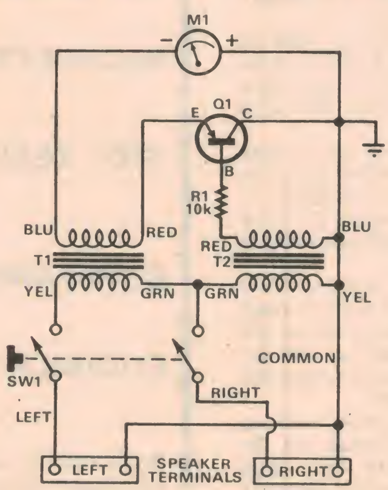
Unfortunately, nowhere does the writer mention this very essential qualification. The whole implication of the article is that perfect stereo balance can be achieved under normal stereo listening conditions.

As we pointed out in the March issue, the whole stereo system relies on the assumption that there will be a difference between the respective channels — sometimes a very obvious difference. As we said: "What about recordings when the strings on the left are supposed to be dominant until it is time for the woodwinds on the right to take over?"

In a roundabout way the writer actually admits to the reality of this point. His circuit shows a meter off-on switch the function of which is explained thus: "The switch keeps the meter shut off when it isn't needed, thus saving wear on its delicate parts!"

What wear? If the system is as easily balanced as implied, and if balance is perfect and complete, there will be no movement of the needle and no wear!

What one would expect and what the article doesn't explain is that there will be side to side movement of the pointer under typical stereo conditions — sometimes quite pronounced — hence the concern to save unnecessary wear and tear on the meter movement.



The circuit of a stereo balance meter, as suggested in an overseas magazine. Work it out if you can. The meter is a 100-0-100 microamp movement, the transistor a 2N1303 and the transformers 1k:100k.

To make sense of the meter reading in these circumstances, one would have to observe the pointer over a period of time and try to set the balance control so that the average deflections to left and right of centre were of the same general order. If the pointer tended to deflect more obviously and continuously to one side or the other, a counter adjustment of the balance control might be indicated.

Of course, such reliance on subjective judgement rather spoils the simple message of the article, but it does happen to be fact.

In short, if we plan to set up some kind of a balance indicator, we should at least get straight what we expect of it.

In other respects also, the text is more eloquent than technically convincing. The writer says: "Nor does balancing by ear ensure a perfect result, because room acoustics and speaker placement can fool your ears."

Fool your ears? Good grief!

If I'm stuck with a furnishing and acoustic situation which puts one loudspeaker at a disadvantage, then surely the logical thing is to favour it with the balance control until the program sounds right.

I subscribe to the old fashioned idea that music is intended for ears, not eyes!

Fool your ears? What next?

The article goes on: "In the same way you can also check out your bass and treble controls to ensure that they are affecting both channels equally." It suggests that, having set the balance control for zero deflection under normal "level" listening conditions, you run the bass and treble controls through their range to see whether they affect balance.

If they don't, that's fine. If they do, your best plan is to adjust for equal channel balance with the controls in the position where you most commonly leave them.

Again, this test could only have some valid basis if performed with a mono signal source.

But, even then, there would be grounds for debate. With frequency response in the spotlight, one's ears are more than ever likely to be the final arbiters.

Last but not least, we come to the circuit.

If the objective was purely to display a difference component, it would be possible to string a suitable isolating transformer between the two actives, rectify the voltage across the secondary, and apply the resultant to a meter. With perfect balance and no difference signal, there would be no rectified voltage and no meter deflection.

This simple circuit arrangement would have the limitation that the meter would always read in the one direction in the presence of unbalance, no matter which channel happened to dominate. In short, it would indicate a balance condition but could not separately display the dominance of the respective channels.

To achieve this objective, one would normally expect to rectify the two signals separately and to apply the DC components to a centre zero meter in such a way that they would tend to deflect the pointer in opposite directions. Under balanced and symmetrical conditions the currents would cancel and the meter would remain at centre zero.

This is what the author has apparently had in mind to do but what one would expect to be a fairly simple and symmetrical circuit turns out to be just the reverse. In

Component Part Lead Times

Product	Dec. '73 Lead Time (Weeks)	Mar. '74 Lead Time (Weeks)
Microcircuits:		
CMOS	25	22
DTL/RTL	18	18
MOS	20	20
Operational Amps	22	22
TL	20	20
Discrete semiconductors:		
Power rectifiers	15	15
Power transistors	20	18
RF transistors	15	15
Capacitors:		
Ceramic	30	36
Film	18	40
Glass	22	28
Mica	26	26
Tantalum	30	60
Resistors:		
Carbon composition	14	14
Metal film	36	37
Wirewound	16	16
Wirewound precision (variable)	16	16
Relays:		
Crystal can	13	16
Delay lines	8	12
Coils	14	16
Printed circuit boards:		
Multilayer	16	16
Two-sided	14	14

If readers had any doubts about the difficult supply position for electronic components, they should be offset by this summary issued by Motorola and published in a recent issue of "Aviation Week & Space Technology". The figures relate to the American avionics industry, which is in a position to press its demands. The 1974 lead times on capacitors are particularly long.

fact, it looks like a beauty for an argument in a club or workshop situation, over a cup of tea.

Has the author been clever, or devious or merely confused? Or has the draftsman made one or more errors? If so, and if the original intention was to use the transistor as a double rectifier, what correction of a presumably simple slip would make the drawing right?

Have fun. It's a beauty!

Getting right away from audio and stereo, a letter to hand from one of our long-standing New Zealand readers registers his early reactions, as a user, to colour television. Omitting some of the more personal matter, his observations might be summarised thus:

Colour receivers are in very short supply and at the time of writing (mid February) there are still only a few thousand colour sets in use.

I have a Philips model K9, 24-inch and I was fortunate enough to get it in time for Princess Anne's wedding, which was transmitted to NZ by satellite. It was just marvellous and the best I have seen anywhere in the world, with the exception of some parts of England itself.

There is plenty of brightness in the picture; in fact, there is brightness to spare.

I am 13 miles from Christchurch Channel TV3.

The Commonwealth Games were telecast completely in colour from Marconi mobile units and again, for all practical purposes, the colour was perfect. So we've had the Royal wedding, the Games opening and the Royal Family, and the opening of Parliament.

In fact, about 95% of current programming is in colour. When the station goes over to colour, there is about ½-second delay so I assume that the receiver's colour circuitry is being triggered by the burst signal.

In fact, I would say that the programs have improved immensely since the introduction of colour and it may well be the same story in Australia. This might be a relevant observation for those who are fond of saying that they will not pay out for a colour set until the programs get better.

The Auckland transmitter was converted over from monochrome to colour, most of the new equipment being solid-state rather than valve. The second station for the area is to be on UHF.

Sets are pretty expensive in New Zealand, with a duty content of 40%. My own set cost $850, with a licence fee of $35 per year (for colour).

Many people have been holding off buying a set, hoping for a price reduction and the ones who got the available sets were those who placed their order early. There would be quite a rush on colour now, if more sets were available.

H. H. (Kaiapoi, NZ)

In fact, I haven't seen a lot of reaction from NZ on the subject of colour TV, possibly because of the limited amount of colour viewing in NZ, and because the subject is still at relatively low key in Australia.

But, meantime, there is a lot of activity in the "pipelines" and it won't be too much longer before receivers appear on the showroom floors with price tags attached and the implication that you can buy and be ready.

When that happens, you can expect a proportion of colour programming to appear on the air — as it has already — so that a significant number of colour receivers will be installed, adjusted and operating reliably by the time the service is officially inaugurated.

Curiously, while I was in the very act of laying out this page, there arrived a rather historic document: the first sales brochure to land on my table, unsolicited, for Australian colour television receivers.

The brochure introduced two of the new HMV models, the "Diplomat" with a 22-inch screen and the "Ambassador" with a 26-inch screen.

The receivers operate to PAL "D" standards and are fully solid-state, with a mixture of IC's, discrete transistors, thyrystors and diodes. Because of this, according to the description, the size and weight of the swing-up chassis is comparable to that of an existing monochrome receiver, even though there is about 2½ times the amount of electronic circuitry.

Of no less interest is the price which is simply shown as "Recommended retail price $750-$850". It is not clear whether this relates to the individual models or is an early rough guide, but it bears a strong resemblance to the figure quoted by H.H.

The Serviceman

How long should you stick with a fault?

Tracking down intermittents can involve a lot of time, in more ways than one. As well as the time spent actually working on the device, there is the period over which the fault is known to exist, yet defies detection and frustrates owner and serviceman alike.

This is a story about an intermittent fault in a TV set. While any story about an intermittent fault is usually worth the telling, this one has a particular claim to fame; it must set something of a record for the length of time taken to track it down.

The story started at a Christmas party; not the Christmas just gone, but Christmas 1972; an important point in the sequence of events. I was introduced to a newcomer to the district who, as soon as he learned I was a TV serviceman, buttonholed me with his tale of woe.

The set was a very well-known make and about 18 months old. It had performed quite satisfactorily for the usual three month guarantee period and for a little while thereafter. Then it started to play up. And, as the owner put it, "Every time we switch it on it's a 50-50 chance whether we will get a picture we can watch. And if it's crook it will usually run for about half an hour and then come good."

At this stage I tried to get some idea of the nature of the fault. He was pretty vague, but I did establish that it was not a geometric fault of any kind. Height and width were normal, it did not involve linearity, and it was not a sync problem. As he put it. "The picture just looks crook." And, from the description he did give, I judged it to be a ghost or multiple image problem of some kind.

He went on to explain that the first thing he did when this happened was to call the manufacturer's service department. They sent out a serviceman, who seemed to fix it, but a few weeks later the trouble was back as bad as ever. He tried the same service department again, with almost exactly the same result.

"So I gave them away. They charged like a wounded buffalo, too!"

After that he tried numerous other servicemen — "Lord knows how many" — but always with the same result; a cure after the serviceman had fiddled with it, then back into the old routine after a few days or a few weeks.

Thus, so far, he had suffered with the problem for something like 15 months — and spent a small fortune on service calls. I wouldn't have been human if I hadn't felt some sympathy for him, particularly in the social atmosphere in which the story was told. I also felt that he had been given a raw deal by the service industry generally and by the manufacturer in particular.

No one knows better than I that intermittent faults can be extremely costly to locate, and that a service department often loses money on them. But surely a manufacturer's own service department can do better than simply prod and poke until the fault vanishes on a temporary basis. Surely they should at least be able to recognise the situation as being intermittent. And having done so, would it have been all that expensive to loan the customer another set while the backroom boys got stuck into the offending chassis? Who knows, they might even have learned something (I did).

Against this background I stuck my neck out.

"Look, I appreciate that you seem to have had a raw deal. I'll have a look at the set, give you my opinion, and I won't charge you unless I can fix it. How's that?"

"Fair enough," he agreed, and we drank to it.

A few days later I was ushered into his lounge room and introduced to the offending set. On my instructions he had not switched it on, so I did so myself and waited. As the picture came up I realised that we were lucky; the fault had elected to appear. As I had surmised, it was a multiple image problem whereby every sharp demarkation between black and white was repeated several times, producing a quite grotesque effect. It is usually caused by ringing somewhere in the signal circuits and experience has taught me that it is almost always in the video amplifier.

The set featured a fold-back chassis which at least made it easy to get at, so I swung this open and made for the video amplifier stage. Using an insulated prod I began tapping the chassis in the immediate vicinity, hoping that, if it was a mechanical fault, I might get some clue as to its whereabouts. And a fat lot of good that did. I hardly touched the chassis before it came good, and nothing I could do would being it back.

In the circumstances, there was nothing I could do except explain the situation to the owner and request that he call me again when the trouble re-appeared.

I heard nothing more from him for about a month, and I was beginning to wonder whether he had written me off as just another failure. In fact, I was on the point of dropping in, when he called me. Apparently it had performed perfectly during the whole of this period and had only just failed again.

This time I approached the chassis with rather more caution. One cause of this type of trouble is a failure of one of the various peaking chokes used in a video amplifier. Where these are wound on a resistor, it is possible for the stage to continue operating, in a fashion, by virtue of the current path through the resistor. And a convenient way to find an open choke is to short it out.

I decided that this was to be my line of attack this time. So I very carefully unfolded the chassis and, with the gentlest touch possible, shorted each choke with a clip lead, one by one. All I established was that no chokes were faulty and that Murphy's law still operated. Before I could make any further tests the set came good. So I left, repeating the advice to call me when it failed again.

It was three months before I heard from the owner again, and he assured me that it behaved perfectly all that time. But now it was playing up again. So I had another go at it. Frankly, I forget what I tried to check this time but it doesn't really matter; the set came good before I made any progress.

In fact, this same procedure was repeated on two more occasions over the following months until suddenly it was Christmas again and I realised that I had been sparring with the thing for nearly a year. I made up my mind that the next time it failed I would suggest a more drastic approach, such as putting it on the workbench until the situation was resolved one way of the other.

Towards the middle of February the owner called me again. It was the same story and I was about to suggest the all-out approach when he forestalled me.

"We're going away for a week's holiday. Would you like to run it in your workshop during that time?"

Well, it seemed an ideal opportunity, so I readily agreed.

When I picked the set up from the customer's home it was faulty. When I set it up on my own bench and switched it on — yes, that's right — it behaved perfectly. And for the next six days I switched it on several times a day in the hope that it would misbehave. Not a bit of it. Perfect performance all the time.

By the seventh day I was desperate enough to try anything. Still convinced that it was in the video amplifier circuit I started prodding and probing — in the manner I had done a dozen times before — in an effort to make it misbehave. Nothing showed up until I removed the shield from the video amplifier valve — a 6EB8 — and tapped the valve.

Suddenly the fault was there and I thought, "You little beauty, it's the valve!" Then I had second thoughts. I had already replaced the valve once and, while not impossible, it seemed unlikely that I would strike two faulty valves in a row.

To settle it I plugged in another valve. That seemed to cure it, but when I plugged in yet another it was back again. I spent the next few minutes withdrawing and inserting valves trying to establish a pattern, but there was none; results were completely random.

Immediately I realised this the penny dropped. It was nothing to do with the valve, but almost certainly something to do with the valve socket or shield.

Thus alerted I began a detailed examination of all the socket connections. All the connections seemed to be intact and well soldered and, as far as I could tell, the socket connections to the valve pins were also functioning correctly. At the same time, I considered the possibility that the socket might have to be changed if no

definite defect was discovered.

It was probably this thinking which lead me to the fault. I glanced at the two eyelets holding the valve shield base to the chassis — and found the fault staring me in the face. The 6EB8 cathode connection, plus all the other chassis connections for the stage, terminated at the one point; a perfectly soldered joint in the centre of one eyelet. The only snag was there was no reliable connection between the eyelet and the chassis. It was easy to show that it could vary from poor to non-existent, and it would undoubtedly vary with temperature, vibration or electrical disturbances.

Not much wonder the stage misbehaved. While I can't be sure exactly what was happening I imagine it became marginally unstable, such that it produced damped oscillations, or ringing, whenever it encountered a steep wave front. This would certainly account for the horrible image it produced.

And so another intermittent fault was finally tracked down, but only after a search extending over nearly two and a half years and involving innumerable servicemen. As I said at the beginning, it must establish some kind of record, though not one about which anybody can be particularly proud, particularly the operator who made the joint, or the examiner who passed it. It had meant two and a half years of frustration for the owner of the set, to say nothing of considerable expense.

But he was a happy man when I told him the story, and even when I presented my account. This was fairly substantial but, I felt, not unfair. After all, I had not charged for any of the abortive visits I had made, so I felt I was entitled to a reasonable fee now that I had finally tracked it down. Assured that the fault really had been found, the owner paid up with a smile.

As a relief from such heavy going, here is a complete change of scene and some stories in lighter vein.

One of my readers, who was a serviceman in the early twenties, has recalled the general background and a number of incidents from that experimental era. As he suggests, it should awaken memories in the older hands and enlighten the new.

This was an era when, in spite of its crude beginnings, radio was finding its way into the homes of the curious. There were no superheterodynes, no multi-element valves, and the humble triode was the wonder of the age. Tuning capacitors were not ganged and moving coil speakers were not known. Speakers were mainly oversize earphones coupled to a horn, though there were a few cone types usually driven by a balanced armature movement. Resistance capacitance coupling was unknown and audio stages were coupled by poorly designed transformers.

Batteries were the only source of power and a typical outfit would use an "A" battery, usually a 6V car battery; a "B" battery consisting of three heavy duty 45V dry batteries to make a total of 135 volts, and a "C" battery to provide bias, normally with several tappings up to -9 volts. The bulk and weight of the batteries alone was sufficient to disqualify any claims to portability.

I was living in a town outside Mackay, some 700 miles north of Brisbane, when the radio bug hit me. My first set was a TRF with reaction, connected to a very long aerial — and it worked. As it was the first set in the district it was customary to hold listening sessions to which neighbours would come from near and far to see this latest wonder of the age.

One visitor was an eighty years old English gentleman. Dressed in his Sunday best he sported a chain across his waistcoat to which was attached a twenty guinea Hunter (watch). From the way he treasured it I have no doubt he firmly believed that the sun rose and set by it.

His first remark, on examining the equipment, was, "You call that a wireless, old chap? Why, it's all bally wires." There were no metal chassis in those days, and all wiring was above the baseboard.

Anyway, the old gentleman sat back and listened to the broadcast. All went well until the announcement, "The time is now 9 o'clock." He jumped to his feet and, with the agility of a western hero beating the villain to the draw, had his precious Hunter out of his pocket. He studied it carefully for a second or so and then shouted incredulously, "It took no time to get here — no time at all!" Then, dazed, he sank back into his chair, apparently completely awed by this aspect of wireless.

The nearest transmitter was in Brisbane, 700 miles away, and reception was possible only at night. Also, since there was no such thing as AGC, reception was often marred by severe fading. Particularly when listening to radio plays it was customary to turn out the lights and this, plus the fading, produced an unexpected side effect; it enabled the young people to get better acquainted.

On one occasion during a play there was a complete and prolonged fade followed by a quite sudden restoration of signal at full strength, as sometimes happened. The timing was perfect; out of the silence one of the play's characters suddenly announced, "They kissed, they kissed; I saw them do it!" And from one of the darker corners of the room there was a subdued commotion as a young couple disentangled themselves and glared sheepishly at the speaker, doubtless suspecting that it had acquired the gift of sight.

The audio system of these old sets often consisted of three transformer coupled stages. Transformers were of quite poor design and exhibited pronounced resonance peaks in their response curves. With more than one having the same peak the response of the system was quite poor, and it was customary to shunt the primary and secondary windings with resistors to smooth the response and render the output intelligible.

One dear old lady complained of noise in her set. A general clean up of connections helped a little, but not enough. Then my attention was drawn to a more probable cause of the trouble; the resistors across the transformers. On changing these the noise vanished and the general "tone" of the set was much improved. Apparently the resistors had gone both noisy and high.

The old lady was delighted and loud in her praise. "It is perfect; it is better than new," she kept repeating. Embarrassed by the shower of praise I quietly packed my tools and edged towards the door. But she called me back. "You did such a good job on the wireless, would you please tune my piano for me."

I had to tell her that I knew nothing about tuning pianos but, to preserve some of her high opinion of me, I refrained from telling her that I was, in fact, tone deaf.

Letters to the editor

The views expressed by correspondents are their own and are not necessarily endorsed by the editorial staff of "Electronics Australia". The Editor reserves the right to select letters on the basis of their potential interest to readers and to abbreviate their contents where this appears to be appropriate.

Omnidirectional?

Referring to your article in the issue of Electronics Australia, March 1974, page eleven, entitled, "The case for omnidirectional speakers", I would like to make a pertinent comment.

The Bose concept prescribes a direct to reflected acoustic ratio of 1:8 approximating that of concert halls, a parameter quite justified.

However, the term, "omnidirectional", is used to describe the Bose 901 speakers. I feel that this is a misnomer. In its truest sense, omnidirectional means the same frequency response at all axes to the speakers including the direct to reflected sound ratio.

The Bose 901 does not satisfy this parameter. Why? The direct sound component is produced by a forward facing speaker, exhibiting the usual characteristics of such a speaker namely attenuated off axis response. This means that this component is highly directional, and one's listening position is as critical as with normal forward facing speakers, if one wishes to achieve the correct direct/reflected sound ratio.

Instead, the Bose 901 should be termed multidirectional, not omnidirectional as satisfied by the Sonab range of speakers. Sonab of Sweden produce speakers that employ the principles of Professor Carllsson. The essential design parameter is similar to Professor Bose's. That is, approximately 90% reflected sound.

Except in one important parameter Carllsson's design produces circular wave fronts, and off-axis attenuation is absent, a feature not present in Bose's speakers. One's listening position is not restricted as much as the position needed for the Bose 901.

Sound propagation naturally is more accurate, and subjectively, more natural. I feel, therefore, that the term omnidirectional be reserved for Carllsson's design, and multiple direction for Bose's.

L. A. G. Hissink (Kambalda West, W.A.)

COMMENT: We agree that there is room for argument about the meaning of the terms omnidirectional and multidirectional. There might also be argument about the point of view expressed here since, with the Sonab system, the listener may or may not intercept some directly radiated sound. Is either system omnidirectional in the sense of approximating a pulsating sphere?

Metric time troubles

Since buying the April issue of E-A and reading the article on Metric Time (p.47) I have shown this article to 30-odd people. About half of them thought it was an April Fool joke, while the others have taken it seriously and are quite worried about it. I am now rather confused and don't know what to think. Although it is pretty far fetched in places I wouldn't be surprised if it were true, considering some of the things that have been changed to Metric. Could you please settle this matter? I am 14 years old, and believe E-A is the best electronics magazine on the market.

Wayne Bertram (Clearview, S.A.)

I wish to congratulate you on an excellent magazine. However the article in the April issue concerning the changeover to Metric Time puzzles me. As this matter has not been publicised before, to my knowledge, and its sincerity has been doubted by associates, I must ask you whether or not it is an April Fool's joke?

Alan Fox (Blanchview via Helidon, Qld)

COMMENT: These readers were not alone in their puzzlement about the item — we received quite a few anxious calls, and we understand that the metric conversion people had many also. Yes, it was purely a little innocent fun, in keeping with our publication date of April 1.

Data transmission

On page 47 of the March issue you described a meter reading system which uses normal telephone lines to transmit data. I am aware that such systems are in use overseas, but from the little I know of the APO it would seem unlikely that such a system would be accepted in Australia. Do you know of any similar system actually approved by the APO, or the position taken by the APO concerning such systems?

C.E.M. (Allawah, NSW)

COMMENT: While we don't have any specific information on similar systems operating in this country, or on APO attitudes towards such systems, we wouldn't rule the idea out. Presumably the data would be transmitted via standard modems, and these are already in use.

Listening to music in the home

When we listen we become engrossed in the music and, with good equipment, we can often obtain the same satisfaction that we would enjoy in the concert hall. Of course, there are differences between the real and the reproduced. Many of these we recognise as such; we come to terms with them and they do not intrude. More serious perhaps are the distortions which we do not consciously notice but which are nevertheless continuously producing a contradiction between the actual and the imagined. They produce listening fatigue, a condition detrimental to the true objective. These distortions have little to do with the popular conceptions of HI-FI or LO-FI sound; on the other hand they have much to do with good or bad engineering.

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Classical Recordings

Reviewed by Julian Russell

Mahler: Symphonies 1-4 — superb reproduction

MAHLER — Symphonies Nos. 1-4 (in box). No 1 in D Major; No 2 "Resurrection" in C Minor; No 3 in D Minor; and No 4 in D Major. Concertgebouw Orchestra of Amsterdam conducted by Bernard Haitink with in No 2 Emmy Ameling (soprano), Aavfje Heynis (contralto) and the Dutch Radio Chorus. Philips Stereo No 6711 003

To award this superb set the detailed review it deserves would fill much more space than is available to me here. I shall therefore give you my opinions on the first symphony as a sort of sample of other riches contained in this box of six discs.

It is important for two reasons not to confuse this recording of the First Symphony with the one Haitink conducted for Philips in 1963. The very first bars show the improved quality of the engineering and, as the work goes on, Haitink's firmer, clearer grasp of Mahler becomes more and more apparent. The dynamic range is very wide indeed and you may need to adjust your volume control with care to bring in the distant brass flourishes at the beginning, which are in quite wonderful perspective, without later being blasted out of your seat by the climaxes. This wide range has been handled without any distortion except for one spot on Side 1, but may well come through your system without this defect.

Taking a wide view of Haitink's interpretation I might describe it as not so self-indulgent as that of the Solti-Bernstein school. Haitink avoids as far as possible Mahler's many emotional excesses and even goes so far as to refine some of the composer's juiciest — and let's face it — banal melodies. Indeed he even goes so far as to ennoble some of them. Nor does he seem to be very much in sympathy with Mahler's grandiose Germanic metaphysical preoccupations. For a long time now I have leaned towards Kubelik's easy charm in these symphonies, issued under the DGG label.

I realise that, by making the above statements, I am perhaps inhibiting general public acclaim for Haitink. Nothing could be further from my intention. Indeed the more I play his readings the better I like them. True there are movements in these symphonies that I prefer in other versions but, everything considered, when it comes to all round enjoyment, I prefer the Haitink issue.

However I would not like you to think that his interpretations are without the dramatic impact so essential in Mahler. To return to the First Symphony in Haitink's easy, unbuttoned approach to the first movement you have whispered pianissimos that set off to perfection the fiery blaze of the climax at the end of it. Next you have the superb rhythmical treatment of the Scherzo interrupted by the schmaltzy tune of what might be called the Trio. In every department the magnificent discipline of the orchestra gives one the greatest confidence in what to expect next. Following this you have the near miraculous faultless intonation of the double bass solo in the "Frere Jacques" tune or the "Funeral March" interlude. The quality of tone produced by the player is quite extraordinary. He makes these usually ungainly and ghostlike strains sound like they come from a real musical instrument. And later Haitink doesn't whip up excitement as does Solti and to an even greater extent Bernstein. Haitink leaves everything to the music itself without interposing his personality between the music and the listener.

The Finale, because of its character, reveals the clarity of Haitink's thinking even more spectacularly than the other three superbly controlled movements. Here you have plenty of real energy without a moment of turmoil. And, importantly, there is no sentimentalisation of the great slow section.

I have chosen the First Symphony as a sample because here you will find all the virtues of a healthy but passionate approach as opposed to the more hysterical readings by other conductors which have their own great audiences. Are these differences irreconcilable to devotees? I fear they might be. But from now on I'm a Haitink man and I am writing this after having heard only the first four symphonies. Does he keep up this exalted standard for the rest of the series? I hope so. If he does you will have an impressive example of mental and emotional discipline insisting on the same response from the orchestra. And I finish by adding that these are my own intensely personal views and that they might well not be yours.

* * *

POPULAR ARIAS sung by NICOLAI GEDDA (tenor) — Excerpts from La Boheme, Manon Lescaut, Gounod's Faust, L'Africaine, La Giaconda, Eugene Onegin, Aida, Un Ballo in Maschera, Tosca and Turandot. With the Royal Opera House, Covent Garden Orchestra conducted by Giuseppe Patane. EMI Stereo No SOELP 10079, Series 299.

This popular tenor offers here a wide, if rather hackneyed selection of items that should please those who go in for this type of recital. Although the timbre of his voice does not please everybody, none can dispute his musicianship. I was therefore a little surprised to find Celeste Aida included. Somehow or other I can't imagine Gedda as Radames though his Puccini arias — and there are four of them here — are faultless in phrasing and tonal quality. I'm inclined to think that his finest achievement on this disc is Lensky's final aria in Tchaikovsky's Eugene Onegin, and running it close is Cielo el Mar from Ponchielli's La Giaconda, the latter a piece that seems to bring out the worst of indiscriminate noise from so many tenors, even those of some repute. The expert will perhaps not approve of Gedda's top C in his Faust excerpt and will I think prefer it the way it was sung by Gigli. But then to compare every aria, note by note, to other performances by other tenors would be fair to none, especially as Gedda's recital, taking it all round, gives you so much to enjoy over a very wide spectrum.

Pop Concert: conventional, typically French

POP CONCERT — Dukas — L'Apprenti Sorcier; Chabrier — Rhapsodie Espana; Debussy — L'Apres — midi d'un Faune; Ravel — Bolero; Saint-Saens — Danse Macabre. L'Orchestre de L'Association des Concerts Colonne conducted by Pierre Dervaux. EMI Stereo No SOELP10075 Series 299.

In this now 12-year-old re-issue the sound is a little thin but still very clear. It is what used to be thought as being typical French sound. L'Apprenti Sorcier is given in the shortened form now generally in use. It is a conventional reading of this elegant piece that well deserves revival. The whole disc will suit those looking for a budget-priced record of typical French music of the pre-World War I period. I can't say that I got very much pleasure from Dervaux' account of Chabrier's Espana Rhapsody. It is so mechanically treated that often, alas, it is all too reminiscent of a merry-go-round. There is a marked tendency to treat the music as inconsequential — which it is not. There is no trace of Chabrier's wit or exhuberance. Older readers may remember what Beecham used to do with it. Debussy's L'Apress-midi d'un Faune on the other hand is beautifully delicate and refined yet not without slumberous sensuality. And in this you will hear some really exquisite flute playing. Dervaux may get a little too excited during the middle section where Monteux would have used restraint to perhaps better purpose.

And some of the more heavily scored passages lack some well-needed clarity. But at an economy price it is eminently satisfactory. There are a few surface prickles on my pressing. And, by the way "apres-midi" is hyphenated as spelt here and not one word as it is spelt on both sides of the record sleeve.

Ravel's Bolero is properly taken in strict time but without the mechanical effect that mars the performance of Espana. But after all these years of listening to it I'm beginning to find the so-often repeated tune a bit wearisome.

Saint-Saens' Danse Macabre sounds very naive nowadays and Dervaux wastes little time in setting a brisk tempo — it may be a bit too brisk for many tastes — and spotlights his soloists, including the bass drum, as if they were standing up to play their piece. I wonder if anyone now remembers the vocal version of Danse Macabre sung by the famous Russian tenor of the 1930s, Vladimr Rosing? It was on a 10-inch 78 and the words consisted mostly of "Zig-a-zig-a-zig."

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CLASSICAL RECORDS

PUCCINI ARIAS sung by MIRELLA FRENI (soprano). Excerpts from Gianni Schicchi; Manon Lescaut; Suor Angelica; La Rondine; Turandot; La Boheme; Tosca and Madam Butterfly. Some with anonymous orchestra conducted by Leone Magiera, others with the Orchestra of the Rome Opera House conducted by Franco Ferraris and Thomas Schippers. EMI Stereo No SOELP 10068 Series 299.

Miss Freni has been deservedly popular for many years and can be heard here at the top of her form in a recital of generous dimensions. To say that she has picked the eyes out of Puccini's oeuvre is not meant unkindly. But Puccini was always so frugal in the use of his star pieces — with the exception of perhaps La Boheme — that I can't imagine him approving a collection of his most effective and beautiful arias on the one disc. However that is all to the good so far as the buyer is concerned, so long as they are not all played at the one session. Miss Freni's style might be described as warmly feminine, and so consistent is this aspect of her art that, taken in too large doses, it is apt to cloy. But if you choose your excerpts discreetly you will find little to complain about. I must protest however, at the summary ending to Liu's aria from Turandot which leaves the listener way up in the air. I realise that this is due to the mechanics of filling a 12 inch side, but a little rearrangement of the items could have made this sudden cut-off unnecessary. In every other way this is a disc I can heartily recommend.

* * *

ELISABETH SCHWARZKOPF SONGBOOK, VOLUME 4 — Lieder by Mozart, Brahms, Wolf, Grieg and Richard Strauss. Elisabeth Schwarzkopf (soprano) with accompaniments by Geoffrey Parsons and Gerald Moore. EMI Stereo OASD No 2844.

One would have thought that Walter Legge's name making a welcome reappearance as the recording engineer of an EMI disc might have ensured a better balance between the voice of his wife, Elisabeth Schwarzkopf, and her accompanist, Geoffrey Parsons. One might also have expected more changes in the singer's style on this disc than is to be found. Schwarzkopf has always had a distinctive style of her own. And how ravishing it could be and still is in some of the items in this recital! But in the past she has usually put this style at the service of the music — and text. But its success seems to have encouraged her into developing this aspect of her art into what has become a mannerism. Schwarzkopf has already an impressive repertoire of recorded recitals behind her but except to those who accept everything she does under the spell of her undeniable charm this will be the least enjoyable. Mozart, Brahms, Grieg, Wolf and Strauss all have around them a nimbus of effortless production and firm sense of pitch.

What will be missed is diction that often loses its former clarity and an undifferentiated warmth — I almost wrote gush — that tends to colour everything with a rose pink wash — if I might be permitted to mix a metaphor. Moreover, one of her best enjoyed characteristics was her sense of sophisticated mischief which in this recital now seems to have grown rather into something arch.

However those who are still unquestioningly under her spell — and they are many indeed — can well ignore my remarks as perhaps churlish, coming from one to whom she has so often given very great pleasure.

Miss Schwarzkopf is supported to perfection — except for an occasional question of balance mentioned above — by two of the world's finest accompanists, Gerald Moore and Geoffrey Parsons.

* * *

BRUCKNER — Symphony No 4 in E flat (Romantic). Chicago Symphony Orchestra conducted by Daniel Barenboim. DGG Stereo No 2530 336.

By now most buyers of serious records will have noted and enjoyed the enormous improvement in the playing of the Chicago Symphony Orchestra, which is here well maintained under the direction of Daniel Barenboim. Indeed much of the playing is of a quality that might well be described as faultless. But I have always thought — and still think — that Bruckner's music needs a fuller maturity than Barenboim can at present devote to it. Not that there is anything radically wrong with his reading. It is always correct though often a little dull, even in this, the most popular and readily enjoyed symphony of that composer. It is my favourite because, frankly, I am no Bruckner fan and tend to think of his works in the words of Brahms, "symphonic boa constrictors." I know that I must be missing something that gives others supreme delight. But there it is and no amount of diligent cultivation of the music changes in any way my reaction to it.

Daniel Barenboim: Israeli conductor-pianist.

The Fourth Symphony opens with a quiet and very beautiful horn passage which, played by a musician of the calibre of Barry Tuckwell immediately arrests the attention. Here it is played so remotely and I am afraid lifelessly that it reminds me of the voice of the man on cigarette advertisements who warns that smoking is a health hazard. This is due to the uncommonly wide dynamic range of the engineering. To bring this horn passage, and other very quiet ones, into comfortable audible range means that the fortissimo passages come out loud enough to hurt the ears. And I might add that I have a very large acoustically designed music room in which to play my records. Moreover the quality of the sound lack's DGG's usual euphonious quality and hardens in the fortissimo passages. The version used by Barenboim is the Haas edition described on the sleeve as the original. I am not sure that this is correct but incline to think it is the composer's own first revision which was played at its first performance.

As I wrote above, Barenboim's reading of the first movement is conventional though without very much depth. He plays the second very well and goes after its intrinsic sound rather than attempting to add Brucknerian "profundity," whatever that might mean. There is an odd bit of intonation in the middle, but apart from that, Barenboim wins some very lovely sound and, in this movement, the narrower dynamic range makes it all much easier on the ears. Yet even here Barenboim doesn't seem to have tight enough control over the composer's ruminating manner to maintain interest at its highest pitch. The massive columnar pillars of sound seem to remain stationary perhaps in deference to Bruckner's "cathedral" type of effect. The famous "hunting" Scherzo is taken faster than I've ever heard it before and here the brass take their punishment heroically in a quite marvellous exhibition of virtuosity. The trio hasn't quite the same impact. I think it looses some of its vitality though might think it graceful enough to compensate for slight relaxation of tension. The Finale offers always effective contrasts between amiability and drive. But all that solemn brass always reminds me of Moses receiving the tables of stone on the lightning-riven top of Mount Sinai—particularly in film versions of the event. Elsewhere you have delightfully rustic interludes with Bruckner managing these alternations between a smiling Austrian landscape and the admonitory Sinaian one with real success until the coda when Barenboim's tension again slackens inexplicably. By the way, the sound that I criticised earlier applies only to the first movement. Everywhere else it's fine.

* * *

CONSTELLATIONS — 30 singers in Ensembles from Rigoletto, Cosi Fan Tutti, La Boheme, Lucia Di Lammermoor; Gounod's Faust, Il Trovatore; Don Giovanni; Carmen; and La Forza del Destino. EMI (Capitol) Stereo No OASD7576.

Some of the stars in this constellation shine very brightly indeed. The casts of each piece are full of the most illustrious names in the operatic field. The choice of excerpts is so wide that everybody will find something to enjoy in this imaginatively produced record. This is a real treasure trove for opera lovers whatever their tastes, covering a variety of styles from what still remains a wide range of excerpts from current operatic repertoire. This, also, is not a disc to be played at a single sitting. One or two items at a time should satisfy even the greediest of opera fans.

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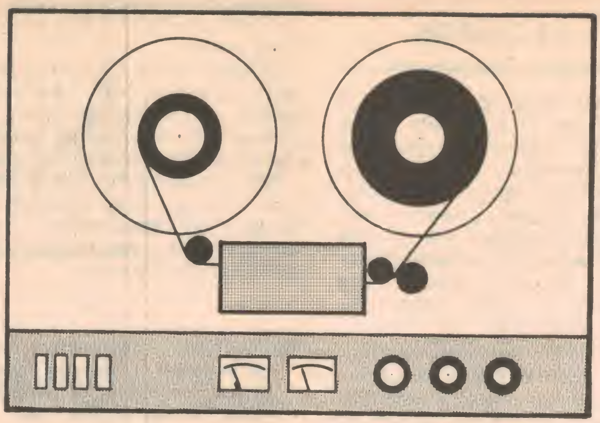

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Variety Fare

Reviews of other recordings

Devotional Records

BORN AGAIN. Pat Boone and the First Nashville Jesus Band. Stereo, Lamb & Lion LL-1007 (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals).

This fully imported American album carries Pat Boone's own label. Recorded against a gently rhythmic Nashville band and chorus, the Gospel songs from the pen of Stuart Hamblen and others have a C&W flavour, but they are very easy on the ear. There are a dozen in all:

That Glory Bound Train — These Hands — I've Got So Many Million Years — Rank Strangers To Me — When My Lord Picks Up The Phone — Suppertime — Born Again — Satisfied — Blackland Farmers — There's A Lot More Layin' Down — Old Brush Arbours — But For The Grace Of God.

The Sound is very clean and the surface dead quiet. A pleasant album with about 32 minutes of music in the grooves. (W.N.W.).

* * *

NOW IS THE TIME. The Jerry Alcorn Trio with orchestra conducted by Rick Powell. Stereo, Word WST-8615-LP (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals).

Jerry, Jeanie Vee, and Jacqueline are the family of American evangelists "Mom" and Dad Alcorn. As a vocal trio they combine to provide a sound which is bright, smooth and very relaxed. What is more, 7 of the 10 numbers presented here are Jeanie Vee's own compositions:

Now Is The Time — All I Need Is Jesus — He Giveth Me Strength — It Was A Happy Day — Something Within Me — Let's Just Praise The Lord — Get All Excited — Bless His Holy Name — Reunion In Heaven — Because He Lives.

Don't let it worry you if the titles are unfamiliar. The songs are very easy on the ear, diction is good and the orchestra backing pleasantly and gently rhythmic. Technically, the quality of this imported album is above reproach. Recommended. (W.N.W.).

* * *

CHRISTIAN PEOPLE. Volume One. Pat Boone, Andrae Crouch & The Disciples. Stereo, Lamb & Lion, LL-1005. (From Sacred Productions Aust, 181 Clarence St, Sydney & other capitals).

If you lack an ear for mod sound you could easily be put off this album by the first track. Most of the other tracks are modern but milder. The reason for this is that the album is some kind of a sampler, with items by several artists and groups: Andrew Crouch & the Disciples, Pat Boone, The Imperials, Children of the Day, First Nashville Jesus Band, Danny Lee & the Children of Truth, Derby Kerner, 2nd Chapter of Acts, The Archers.

There are twelve tracks in all: Christian People — I Wish We'd All Been Ready — He's Got The Whole World In His Hands — Put Your Hand In The Hand — Can I Show You — Jesus Is Coming Soon — One Way — Me And Jesus — Amen, Praise The Lord — Too Close — I'm So Happy — It Won't Be Long — A Brighter Day.

A fully imported album, it is technically and musically competent but it is aimed squarely at the Gospel youth audience. If you're part of that audience, you'll love it. If you're one generation removed, you'll probably think differently! (W.N.W.)

Instrumental, Vocal and Humour

BARBIROLLI CONCERT HOUR. The Halle Orchestra conducted by Sir John Barbirolli. Stereo, Astor "Golden Hour" Series, GH522.

GOLDEN HOURS OF CLASSICAL BONBONS. Various artists and orchestras. Stereo, Astor "Golden Hour" Series, GH515.

Almost all of the items included in these two selections turn up time and gain in discs of light classics, and superficially, there appears little to distinguish them from innumerable other budget priced discs of their type. However, there are two points worth noting. One is the generous playing time, (although one need not take the 60 minutes implied by the series title too literally); two, only top ranking artists and orchestras are featured, which is very often not the case in this type of fare.

Barbirolli must have had a lasting affection for lighter musical fare, as he often recorded items of the type to be found in GH522: Poet And Peasant Overture — Strauss's Pizzicato Polka — Gypsy Baron Overture — Morning Mood From "Peer Gynt" — Morning, Noon And Night In Vienna Overture — Tales From The Vienna Woods — Andante Cantabile From Tchaikowsky's String Quartet No 1 — Die Fledermaus Overture — Stars And Stripes Forever March.

Barbirolli is again the conductor with the Halle Orchestra in many of the titles in GH522, with Trumpet Voluntary — Dance of the Hours — Intermezzo To Cavalleria Rusticana — Blue Danube Waltz — In The Hall Of The Mountain King from "Peer Gynt" — Light Cavalry Overture. For the rest, Sir Adrian Boult conducts the London Philharmonic in Berlioz's overture "The Roman Carnaval" — Mindru Katz presents a suitably fiery version of Chopin's "Polonaise in A Flat" — and Ralph Downs plays a Bach Toccata and Fugue, in F major.

To summarise briefly, two very worthwhile discs of light classics, which complement each other admirably, with the performances leaving little or nothing to be desired. Since I gauge the age of the recordings to be at least ten years and possibly even older in some cases, some allowances must be made for recording quality. While good enough to satisfy most listeners, those who demand the latest in technical brilliance should pay the extra two dollars for Phase Four and similar labels. (H.A.T.)

* * *

LOVE DUETS. Joan Hammond and Charles Craig, with the Royal Philharmonic Orchestra, conducted by Vilem Tausky. Stereo, His Master's Voice SOELP. 10059, Series 299.

The title is apt, and the duets are some of the best known ones from favourite operas: From "La Boheme," Your Tiny Hand Is Frozen — They Call Me Mimi — Lovely Maid in the Moonlight; From "Tosca," Mario! Mario! Mario!; From "Madame Butterfly," Ah, Love Me A Little; From "Faust," The Hour Is Late; From "Aida," I See Thee Again, My Sweet Aida.

Presumably all these items were recorded specially for an HMV disc some years ago, and are now reissued on this budget price disc. If you do not demand the ultimate in high fidelity, you will find much to enjoy in this recital, as both the singers have very fine voices, and it may influence your decision to know that they sing here throughout in English. (H.A.T.).

* * *

MUSIC OF SPAIN AND LATIN AMERICA, played by Henryk Szering, violin, and Claude Maillols, piano. Stereo Philips 6500 016.

"The program . . . falls naturally into four sections: Music from Spain, Brazil, Argentine and Mexico, in that order." So we are informed by the sleeve note, and the program comprises familiar items such as the Spanish Dance from "La Vida Breve" and two of Sarasate's Spanish Dances with other compositions which will be quite unknown to many people. Space limitations do not allow me to list them all, with the composers, but if you have a taste for Spanish type music, I think you will enjoy this recital as much as I did, particularly when played as expertly as do the two artists here — both outstanding in their art. The Philips recording is beyond reproach. (H.A.T.)

* * *

TWENTY YEARS OF BEAUTIFUL MUSIC. Golden Hour Series. The Dimensions In Sound Orchestra. Stereo, Astor GHC-1052.

You like medodious music? Familiar music? Lots of it? Then you'll certainly like this recent addition to Astor's "Golden

Reviews in this section are by Neville Williams (W.N.W), Harry Tyrer (H.A.T.), Leo Simpson (L.D.S.), Gil Wahlquist (G.W.), and Norman Marks (N.J.M.).

Hour'' series. There are twenty separate numbers and the disc does play for an hour. Included are such established favourites as: Autumn Leaves — Love Is A Many Splendoured Thing — Moon River — Raindrops — Never On A Sunday — Taste Of Honey — Three Coins In A Fountain — On A Street Where You Live — Girl From Ipanema — Shadow Of Your Smile — Up, Up And Away — Love Story Theme, and so on.

To get all that on the one disc, the recorded level is a trifle below average but the only hint you will get of this is the need to run the volume control a trifle higher than usual for normal listening volume. There's certainly no problem with surface or background noise. Recommended, if you'd like a generous helping of pleasant music for relaxation. (W.N.W.)

* * *

TOM SAWYER. Incidental Music. 101 Strings Orchestra conducted by Jack Dorsey. Stereo, Astor S-5295.

Not having seen the film, I approached this as just another release by the well known 101 Strings Orchestra. On this basis it produced two immediate reactions: (1) The performance has more purpose and zest than the orchestra's usual ''ten favourites'' approach, and (2) familiar or not, the music is very listenable indeed.

The titles, all but the last two from the film: River Song — Hannibal Mo — A Man's Gotta Be — How Come? — Free Bootin' — If'n I Was God — Tom Sawyer — Aunt Polly's Soliloquy — Catfish Creek — Huck's Island.

Perhaps I should mention that the third quality about the album is the bright, clean sound quality, good surface and a spread which is fine in stereo and even better in simulated 4-channel. As you might have gathered, I liked it! (W.N.W.)

* * *

BOB ROWE'S MUSIC BOX. Stereo, Harlequin series (Festival) L-25046.

The jacket notes explain that Bob Rowe started with guitar in 1963 and then, in 1968, started to play around with multi-tracking. He's gone on from there, adding more instruments and more tracks, till his current stage act presents him as a one-man ensemble with anything up to thirteen instruments other than the one he happens to be playing! All this virtuosity is lost on the record, of course, and the sound is simply that of an ensemble, with as many pairs of hands as appropriate.

In fact, the end result of all this electronic two-timing is not too far removed from a made-in-Moog ensemble: bright, gimmicky and quite pleasant sound.

The tracks: Get Down — Skylab — Something — Son Of My Father — Up, Up And Away — Crocodile Rock — Blockbuster — Claire — Storm In A Teacup — Theme From ''Love Story'' — Girl From Ipanema — Mexican Flyer.

The quality is very clean and it spreads nicely in simulated 4-channel. At $3.99 for twelve tracks, it's quite good value. (W.N.W.)

* * *

NASHVILLE NOW. Featuring the Nashville Jets. Quadraphonic Project 3 (Festival) LQ-34992.

If you don't happen to know the Nashville Jets, you certainly will know the producers of this album: Enoch Light and Tony Mottola. And you will recognise the style, with varied and original arrangement, and

Three ''Golden Hours'' of popular organ

THE MAGIC OF THE WURLITZER. Joseph Seal. Stereo, Astor Golden Hour Series GH-552.

Recorded in the ABC Theatre at Kingston upon Thames, this is the thirteenth album that organist Joseph Seal has made for Pye Records — an indication, surely, of his long-term popularity.

His program here is strictly one of traditional favourites played in equally traditional theatre organ style. In all, there are eighteen tracks, some of them medleys and space prohibits listing all the titles. But here are just a few: Ciribiribin — Lullaby Of Broadway — Fantasy Impromptu — I'll Walk Beside You — Jalousie — Smoke Gets In Your Eyes — As Time Goes By — Stella By Starlight — You'll Never Know.

The quality is lacking somewhat in sparkle and the dynamics have been restrained to ensure a full hour of playing time, so that the disc could hardly qualify as a hifi experience. But, on the other hand, the sound is smooth and relaxing in the Jesse Crawford style and, if that's in your line, $3.99 is not that much to pay for a full hour's program. (W.N.W.)

* * *

GOLDEN HOUR OF THEATRE ORGAN FAVOURITES. Joseph Seal. Stereo, Astor GH-517.

If the serial numbers mean anything, this is the earlier of the two Joseph Seal albums in the Golden Hour series but, it would qualify for my vote as the better one. It has better treble response and presence, and greater dynamic range. In fact, Joseph Seal seems much more intent on giving the ABC Theatre organ in Kingston Upon Thames a workout, rather than soothing his audience.

There are seventeen tracks making up the hour's program, and I list a few for your guidance: Gershwin Melodies — Stardust — Glass Mountain — Viennese Nights — La Rosita — Cole Porter Medley — Seventy Six Trombones — Down Memory Lane — Misty — Play Gipsy — Ah Sweet Mystery Of Life Melodies From The Gondoliers.

At the budget price for a 60 minute program, this just has to be good value for an organ enthusiast. (W.N.W.)

* * *

GOLDEN HOUR OF HAMMOND HITS. Johnny Patrick at the Hammond Organ. Stereo, Astor GH-528.

For this hour-long album, British organist and TV personality Johnny Patrick returns to that simple one-time formula of percussion plus Hammond flutes, and very little else. But, in saying that, I must be careful to mention his own high sense of rhythm and facile finger work. He makes it all sound so easy.

Don't asks me to list all the titles but here's a few of the many: Spanish Flea — Yellow Submarine — Puppet On A String — Get Me To The Church On Time — Raindrops — Chirpy Chirpy Cheep Cheep — On The Street Where You Live — Do You Know The Way To San Jose? — Girl From Ipanema — Serenata.

The sound is clean and sufficiently free from dynamics to pose no problem in fitting 30 minutes on to each side. But only you can say whether the traditional Hammond plus percussion sound pleases you or bugs you. (W.N.W.)

VARIETY FARE

the usual array of very capable musicians. There are eleven numbers on the two sides: Kodachrome — The Night The Lights Went Out — Alone Again, Naturally — Winchester Cathedral — Yellow Rose Of Texas — Oh Babe, What Would You Say? — When The Saints — Tie A Yellow Ribbon — King Of The Road — Your Cheating Heart — Out Of The Question — I Never Promised You A Rose Garden.

The quality is very clean, the surface quiet and it's well worth adding to your 4-channel collection if you're not already overstocked with yellow roses and yellow ribbons! (W.N.W.)

* * *

I BELIEVE IN MUSIC. Ray Davies, His Funky Trumpet and the Button Down Brass. Quadraphonic, Astor QUAD-1023.

Without arguing too much about what "Funky" means, Ray Davies and the Button Down Brass Orchestra provide a program as animated as it is varied. There's a fair element of tortured brass, of course, but an electronic organ and other gimmickry is in evidence helping justify that "Funky" word.

There are twelve tracks in all: Beautiful City — My Love — Mach 1 — God Bless The Child — Swing Low Sweet Chariot — I Believe In Music — Heavy Water — Killing Me Softly With His Love — When The Saints — Tea For Two — Mystery Movie Theme — Day By Day.

The surface is very quiet, the quality very clean and the 4-channel effect routine.

However, if you're not familiar with Ray Davies and the Button Down Brass, you'd better sample two or three tracks before you unbutton your own brass. (W.N.W.)

* * *

HOT BUTTER. Moog Hits. Stereo, Musicor Records (Festival) L-34984.

An encore to the successful "Popcorn" album by the Hot Butter group, this one combines a Moog synthesiser expertly played by Stan Free, with ondioline, drum, bass, electric and "dry" guitars, piano, tambourine, temple blocks, shaker, finger cymbals — and the human voice. As you might imagine, a lot of unusual sound emerges from the loudspeakers, mercifully not all at once! The tracks:

Slag Solution — Sounds Simple — Percolator — Wheels — Skokian — Russian Whistler — Space Walk — The Masterpiece — Requila — Syncopated Clock — Mah-Na Mah-Na — Mexican Whistler.

As is usual with records born in a Moog environment, and of electronically orientated parents, the sound is very clean, and with a high order of separation; this is obvious on 2-channel and even more so on 4. But, as also common in such a situation, there is a tendency to produce Moog-like sound with the other instruments, rather than the reverse. This one will sound novel, or be just another album of electronic put-togethers, depending on how much of it you already have in your collection! (W.N.W.)

* * *

IRISH SINGALONG. The Bill Shepherd Singers. Stereo MCA / Astor MAPS-6999.

When I put this album on the turntable, I expected to hear the ultra disciplined sound of a typical professional group. But the Bill Shepherd Singers are neither as numerous nor as completely blended as this. It is quite easy to pick individual voices in the slower numbers and maybe the slightly more spontaneous treatment is appropriate for an Irish Singalong:

When Irish Eyes Are Smiling — Rose Of

(Continued on page 107)

Reader's Digest 9-record album

WONDERFUL WORLD, WONDERFUL MUSIC. Various artists. Reader's Digest 9-record set.

One can certainly not deny that Reader's Digest spare no effort in producing an attractive set of records. Each of the nine records in this set has its own plastic sleeve and colour printed envelope with copious notes on the origin of each of the tracks. The whole set is housed in a protective case which carries the title, "Wonderful World, Wonderful Music."

The case itself is sealed in polythene and packed in a carton for transit so that it is certainly well protected.

There are a great variety of artists and they are all from the CBS studios who collaborated with Readers' Digest in producing this set. All of the tracks have been previously released by CBS on their own full-priced albums. On this set, Readers' Digest has mixed them together so that each record has a theme.

For example, record 3 is entitled "South Of The Border" and has tracks with a Latin-American flavour. Tracks are as follows: "Spanish Eyes" by Andy Williams; "Marianne," "Desafinado" and "Guantanamera" by Andre Kostelanetz and his orchestra; "Manha De Carnaval," "Spanish Harlem" and "One Note Samba" by Percy Faith and his orchestra; "The Girl From Ipanema" by the New Christy Minstrels; "Ebb Tide" by Robert Goulet; "Fly Me To The Moon" by Johnny Mathis; "Summertime" by the Brothers Four; "Jamaica Farewell," "Besame Mucho" and "Shangri-la" by Ray Conniff and his orchestra.

As a further example, record 5 is entitled "Party Time." Tracks are: "Those Were The Days" and "Sunny" by Robert Goulet; "I Want To Hold Your Hand," "What The World Needs Now" and "These Boots Were Made For Walking" by the New Christy Minstrels; "Secondhand Rose" by Barbra Streisand; "Make It Easy On Yourself" and "Rhythm Of The Rain" by Percy Faith and his orchestra. And so on.

Space does not permit listing of all the tracks on all discs but readers will get the message that the music is strictly "middle of the road" and not likely to upset anyone who watches programs like Bobby Limb's "Sound Of Music" or Eric Jupp or even the Melbourne Show Band. Some of the record themes are a little vague but there is a lot of good music contained on the discs.

I was not so happy about the recording quality on some of the discs, however. Generally, it is good but in some places the strings are strident and the upper bass seems over-emphasised and boomy. While this may impress some people listening to cheap stereograms, it can be quite irritating on a good system. Surface noise was also higher than it should be — I cannot report that any of the discs had a really quiet surface. On the other hand, surface noise was never really obtrusive. However, if you are critical of this aspect, think twice before you send away for the album.

The album can be summed up as a lot of music value for your money but quality is a problem on some discs for some purchasers. (L.D.S.)

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POWER HANDLING CAPACITY 30 Watts R.M.S.

DRIVE UNITS:
Magnavox 8-30 High Performance 8in Bass Unit • Magnavox 6.J — 6in Mid Range Speaker • Philips High Fidelity Dome Tweeter
COMPLETE SYSTEM in 1.6 cubic ft. cabinet. In Walnut or Teak Veneer (Size 24" x 15½" x 11").

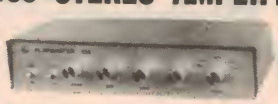
$72.00 ea. *Regret no Mail Orders for Complete System.*

SPEAKER KIT: (less cabinet) comprising 1 8-30 speaker, 1 6J speaker, 1 Philips dome tweeter, 1 1mh. inductance, 1 8 mfd. & 1 4mfd. polyester condenser, 1 3" & 1 6" tube, innabond & speaker silk, plans for cabinet.

$40.00 *Reg. Post & Packing $3 Extra.*

PLAYMASTER 136 STEREO AMPLIFIER

As featured in Dec '72 issue of Electronics Australia



High fidelity amplifier with an output of 13 watts R.M.S. per channel, frequency response 20Hz to 120kHz, distortion 0.2% mag. input equalised to R1AA, bass & treble controls, provision for simulated 4 channel.

Complete kit of parts including **All Transistors. $65.00** as above but less Fairchild **special transistor offer $58.00.** Reg postage $2.00 extra.

As an added feature to the 136 amp we have added provision for headphones with phone jack & switch mounted on front panel which is silver anodised with black lettering & matching knobs. We have also had a special transformer wound for this unit with separate 6v winding for indicator bezel & with electrostatic shield.

NEW N.C. 310 DELUXE TRANSCEIVER

For 27240 or 27880 Khz operation (state which required) with switch position for additional two-channels tone call signal, noise squelch control, circuit contains 13 transistors, diode and thermistor. Transmitter stability crystal controlled .005 Ceramic filter. Aerial 9 section telescopic powered by 8 1.5v UM3 batteries. Range up to 10 miles depending on conditions. Battery check meter. Attractive and durable die cast case with provision for external speaker, aerial and power supply.
$49.50
Post $1.00 extra.

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CLASSIC RADIO

245 PARRAMATTA RD, HABERFIELD 2045
PHONES 798 7145, 798 6507

VARIETY FARE

Tralee — Kerry Dance — A Little Bit Of Heaven — I'll Take You Home Again Kathleen — Shenanigans — Too-Ra-Loo-Ra-Loo-Ral — Mother Machree — Come Back To Erin — The Girl I Left Behind Me — Molly Malone — Christmas In Killarney.

Quality is okay, playing time is about 35 minutes and if you, like me, have a soft spot for the Irish countryside, it will be no stint to be reminded of it by the Bill Shepherd Singers. (W.N.W.)

* * *

BREEZY. Original Film Sound Track. Michel Legrand and his Orchestra. MCA MAPS 7171 Astor release.

There appears to be a continuing theme running through the ten numbers on this disc; no doubt if one had seen the movie this would be more obvious. Apart from the title track, the other numbers are: Rockin' chair — I Will Remember You — Allegretto Vivace — Going Down To Sorrow — Breakfast-Time — Out Of Danger — Alone In The House — Walking On The Beach — A Whole Year.

The quality is excellent and, except for the wordless vocal in part of "I'll Remember you," I found the record enjoyable. The style ranges from the semi-classical "Allegretto Vivace" to themes reminiscent of "Hair". N.J.M.)

* * *

NOEL and GERTIE and BEA. Noel Coward, Gertrude Lawrence and Beatrice Lillie. Mono, Parlophone series 275. PMEO-275.

This is nostalgia with a vengeance. According to the notes, Beatrice Lillie made her stage debut in 1914 and even I am not as old as that! In fact, the material on this album is of more recent vintage than that but, even so, the ranks of theatre goers of the early thirties must be getting rather thin by now; and that means the ranks of those who are likely to be switched back on by the contents of this album.

If you aren't so affected, it won't be for lack of material on the fourteen tracks. There are groups of "successes" by Noel Coward, by Gertrude Lawrence and by Bea and Gertie together.

Among the other items by the respective artists are songs like: Baby Doesn't Know — What Now — World Weary — A Baby's Best Friend — Rolled Into One — Winnie The Window Cleaner — We Were Dancing — Julia, and Shoot The Rabbit.

The recording is mono, re-mastered from early recordings and, with few exceptions, notable for the lack of background noise. If you want to remember or to study these immortals of yesterday's theatre, the album will be excellent value. But if you lack that basic motivation, you'll find it a yawn. (W.N.W.)

* * *

SONNY AND CHER LIVE AT LAS VEGAS. Stereo, MCA Records MAPS 7141, two disc set in folding sleeve.

A brief look at the much publicised Sonny and Cher Show on television was sufficient to convince me that this type of entertainment was not for me. My reaction to these discs was the same — too much noise (was it really necessary to have the band playing all through the comedy routines?), too much untuneful singing, too little real wit . . . plainly not a set which will find a permanent place in my collection.

On the other hand, there will undoubtedly be Australian TV viewers who have enjoyed the couple's slick show, and these may be sufficiently interested in a recorded performance. For their benefit I will enumerate the song titles: All I Ever Need Is You — I Can See Clearly Now — You've Got A Friend — Where You Lead — You'd Better Sit Down Kids — A Cowboy's Work Is Never Done — I Got You Babe — Gypsy's, Tramps And Thieves — Brother Love's Travelling Salvation Show — You And I — Superstar — Bang, Bang. In addition, there are two comedy dialogues and one monologue by Sonny. These are mainly concerned with the couple's sex life, which is apparently the only acceptable subject in American night clubs. If you are interested, the sound quality, for a "live" recording, is good enough, but some better console work would have helped the balance considerably. (H.A.T.)

* * *

RICHARD BONSALL SINGS. The Lord's Prayer and 10 Other Titles. Stereo, Axis (EMI) 6038.

New Zealand lad Richard Bonsall has very deservedly won acclaim at vocal competitions, on stage and on television. He has a voice of quite unusual purity, firm pitch and a sensitivity of presentation that belies his years. He is complemented to perfection by piano accompanist Alan Pow. The whole program is gentle and unhurried, and very relaxing, if that is your mood.

The 14 tracks of a generous program include: Ave Maria (Gounod) — On Wings Of Song — The Lorelei — Christmas Cradle Song — The Last Rose Of Summer — Gesu Bambino — The Lord's Prayer — Greensleeves — Santa Lucia — Ave Maria (Schubert) — Skye Boat Song — Rose Of Tralee — An Island Sheiling Song — An Eriskay Love Lilt.

The quality is good and the surface whisper quiet. Granted that boy soprano records may have limited appeal but I can only say that this one is good. (W.N.W.)

* * *

COL JOYE. HEAVEN IS MY WOMAN'S LOVE ATA Records L 35036 Festival release.

Col Joye has been a perennial favourite on the local music scene and this record should enhance the number of his admirers. Twelve numbers with a soft country flavour make up the menu with titles like: Heaven Is My Woman's Love — What Am I Gonna Do — Sweet Country Woman — Blues Can't Keep A Good Man Down — Old Dogs, Children And Watermelon Wine — You Are What I Am — Ain't Nowhere To Go — If It Feels Good Do It — Happy Days — Sunshine In Your Face — Seed Before The Rose — Ray Of Sunshine. The quality is excellent, I think you'll like it. (N.J.M.)

* * *

TOMMY OVERSTREET. My friends call me T.O. DOT L35019 Festival release.

A deep, pleasant voice brings fresh interest to a group of old and new Western hits such as; Send Me No Roses — Welcome To My World Of Love — Sleep My Lady — You Got Everything That You Want — I'll Never Break These Chains — Tie A Yellow Ribbon Round The Old Oak Tree — Sweet Country Woman. Eleven tracks in all, with good quality. (N.J.M.)

Product reviews & releases

New range of test gear from Trio

Trio has recently produced a new range of test equipment with attractive styling and good performance. The range comprises the CO-1303A oscilloscope, AG-202A audio oscillator, SG-402 RF signal generator and VT-108 Fet volt-ohmmeter. All the instruments are completely solid-state and are light and compact.

Anyone who has contemplated the purchase of test equipment knows that it can be difficult to choose and to pay for. If it is low-priced it often looks amateurish and has mediocre performance, while the good gear costs the earth. However, Trio have a range which has good styling, good performance and reasonable price.

The four Trio instruments which we have tested in this instance all have similar styling and some use the same case. The cases are finished in blue crackle enamel, while the front escutcheons are black plastic with a satin-finish aluminium insert. The main control knobs are grey.

The largest of the four instruments is the CO-1303A solid state oscilloscope, which has a 75mm diameter tube. Case size is 186 x 140 x 310mm (W x H x D) including knobs, feet and handle. Power requirement is a mere 15 watts at 240VAC. Weight is a light 4.3kg.

Maximum sensitivity of the vertical amplifier is 20mV / cm while the bandwidth is DC to 1.5MHz for DC coupling and 2Hz to 1.5MHz for AC coupling. Input impedance is 1 megohm shunted by 30pF. Timebase sweep frequencies are 10Hz to 100kHz in four ranges.

There is much room inside the case and the single printed board measuring approximately 125 x 160mm looks rather lost. Another interesting impression one gains from the internal construction of the unit is that the power transformer has been very carefully orientated to minimise hum on the trace.

Clearly, the CO-1303A is an up-to-the minute circuit design which has been carefully optimised. All told, it uses 8 bipolar transistors, 2 FETs plus assorted diodes. Not bad for a bandwidth out to 1.5MHz, with useable response well beyond that and maximum sensitivity of 20mV / cm.

The AG-202A audio oscillator is the usual Wein bridge circuit but with a FET input stage and variable capacitance element. Four switched ranges are provided and frequency coverage is from 20Hz to 200kHz. Both sine and square wave outputs are provided. Maximum sine wave output is 10V RMS at 600 ohm output impedance, while rated distortion is less than 0.5pc from 50Hz to 100kHz.

Maximum square wave output is 10V peak-peak while rise and fall times are 0.5uS or less. Overshoot is quoted at 3pc or less while droop at 20Hz is 10pc or less.

An attractive feature of the unit is that it can be externally synchronised with other waveforms. This feature is not usually available on low distortion generators.

We measured total harmonic distortion at considerably less than the 0.5pc specified, and we were able to confirm that all other specifications were at least equalled or bettered. Again, the internal construction details leave little to be desired. Of special note was the carefully mounted two-gang tuning capacitor, which is completely shielded in its own metal box.

The SG-402 RF signal generator is a straightforward piece of gear which perhaps should be termed an RF oscillator rather than a signal generator, (the term "generator" normally assumes a "laboratory" standard of performance). Frequency coverage is 100kHz to 30MHz in six bands.

Accuracy of the dial calibrations is stated to be within plus or minus 1 pc. Output signals are coupled via jack sockets on the front panel, although a BNC coaxial socket would have been preferable. Maximum RF output is 0.1V RMS. The RF attenuator is not calibrated, which will be regarded as a drawback by many users.

Amplitude modulation is provided internally at 400Hz and 40 pc or may be provided from an external source via a jack socket on the rear panel, over the range from 50Hz to 10kHz. Again, we were able to confirm all the specifications.

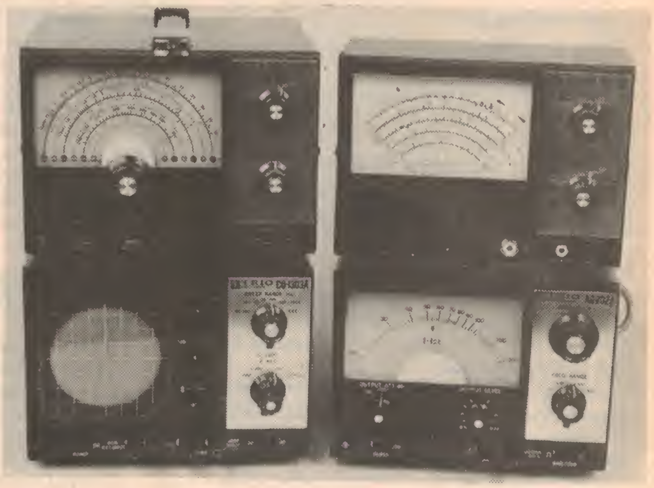
The cheapest but perhaps the most interesting instrument in the line-up is the Trio VT-108 Fet volt-ohmmeter. It measures AC and DC voltages in eight ranges (each) from 0.5 to 1.5kV FSD, and resistance from 10 ohms FSD to 10 megohms FSD.

Input resistance and capacitance on all DC ranges is eleven megohms shunted by 3 picofarads or less. Measurement accuracy is 3pc of FSD. Peak-to-peak detection is used in the supplied probe to give a frequency range of 20Hz to 5MHz. Input impedance of the probe is 1 mehohm shunted by 145 picofarads on ranges below 150V, and 80pF on other ranges.

Accuracy for AC measurements is quoted as plus or minus 5pc and meter indication is RMS for sine waveforms.

A most unusual feature is included in the VT-108, that of memory. When making voltage measurements, the meter indication can be held for long periods after the voltage input has been removed. What actually happens in the Memo mode is that the input voltage to the usual FET differential amplifier is fed to a capacitor. This is monitored by a FET source-follower which in turn is monitored by the usual FET differential pair.

While the capacitor is only .047uF the extremely high input impedance obtainable from the FET source-follower enables a long time-constant to be achieved. This means that the voltage reading can be held for a long time. Typically, we found that we could hold a voltage reading for fifteen minutes with the scale indication changing less than 10 per cent of scale deflection. And the reading increases with time instead of decreasing. This can be a very handy feature when recording or making comparisons of voltage measurements.



The four instruments reviewed are pictured at right. They are (from left to right and top to bottom): the SG-402 signal generator, the VT-108 volt-ohmeter, the CO-1303A oscilloscope, and the AG-202A audio oscillator.

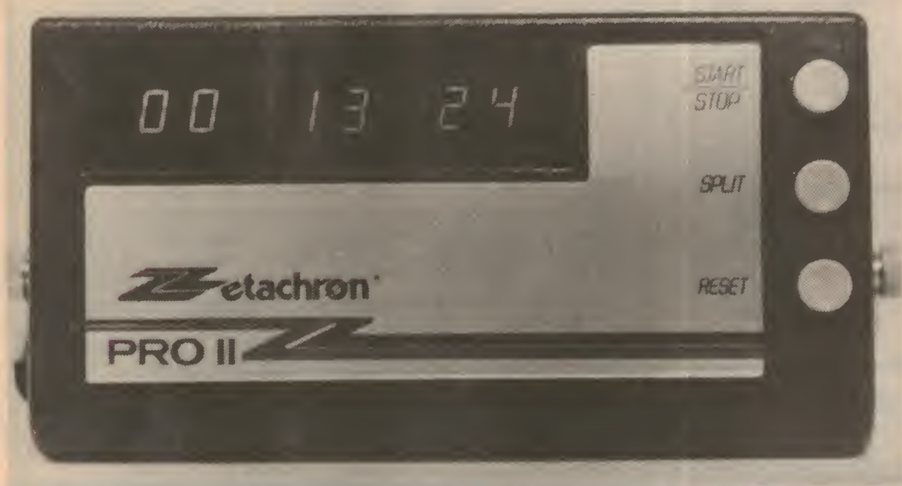
All told, Trio have come up with a very attractive range of instruments that will find many applications on the workbenches of hobbyist and technician alike. They are attractively styled and perform well.

Prices are as follows: CO-1303A oscilloscope, $135 plus tax; AG-202 audio generator, $75 plus tax; SG-402 RF signal generator, $60 plus tax; VT-108 Fet voltmeter, $68 plus tax.

Further information can be obtained from the Australian distributors for Trio equipment, Parameters Pty Ltd, 68 Alexander Street, Crows Nest, NSW. (L.D.S.)

Crystal controlled digital stopwatch

Manufactured by Zeta TimeTel Corporation of Santa Ana, California, the Zetachron Pro II digital stopwatch is eminently suitable for recording elapsed time in a variety of applications such as sporting events and laboratory work. In addition to inbuilt manual control facilities, the new unit may be interfaced with a range of optional automated remote control facilities.



Weighing only 14.5oz and easily held in one hand, the Zetachron Pro II digital stopwatch is quartz crystal controlled, allowing exceedingly accurate measurements of elapsed time to be made. In its most sensitive mode, readings accurate to 1/100 of a second can be obtained. Standard equipment supplied with the unit includes an AC adapter and a weatherproof clear plastic case.

The Zetachron Pro II can be operated in three timing modes: hours, minutes and seconds; hours, minutes and hundredths of minutes; and minutes, seconds and hundredths of seconds. The hour modes can be preset to any hour by using two smalll buttons at the back of the clock, allowing the unit to be used as a time-of-day clock in a twelve hour operational mode. Up to 12 hours, 59 minutes and 59 seconds of elapsed time can be recorded.

Physically, the unit is well constructed in a sealed high impact vinyl covered case. The circuitry is fully solid state, employing a quartz crystal as the timebase and using ⅜" high Sperry planar gas-discharge readouts. The unit is powered by rechargeable nickel-cadmium batteries capable of providing in excess of 30 hours continuous operation. Alternatively, it may be operated from the mains through the AC adapter provided, which also serves to recharge the batteries, or from an optional field battery pack.

Three push on / push off buttons are used to control the operation of the digital stop watch, and these are grouped together on the right hand side of the front panel. These are (from top to bottom): the start / stop button, the split button, and the reset button. The split button serves to lock the display on a particular reading while the unit continues to count internally. The display is unlocked by simply pushing the split button once again, allowing the unit to display the total elapsed time.

The on / off switch and the mode switches are all grouped together in a row on the back panel, together with the two small buttons for time setting. Also on the back panel are three sockets which accept the AC adapter / re-charge unit and the optional remote control facilities offered with the unit.

A number of accessories are offered with the Zetachron Pro II digital stop watch, and these include:

- a clipboard holder of vinyl or heavy duty aluminium,
- a momentary or alternate action hand switch,
- a 12 / 6V adapter to enable the unit to operate from a car battery,
- a field battery pack,
- an electric eye actuator, and
- a range of specialised automatic remote control facilities.

Accuracy of the Zetachron Pro II is claimed by the manufacturer to be plus or minus 0.001pc of the original setting at room temperature, together with a possible drift variation of plus or minus 0.003pc due to voltage supply variations and a drift of plus or minus 0.002pc over a temperature range of 0 to 50deg C. The accuracy of the unit can thus be regarded as better than 0.006pc.

Our checks of the unit supplied for review confirmed its basic accuracy, and broadly speaking we found the Zetachron Pro II a very businesslike little unit. It should be found very suitable for virtually all of the applications for such devices; our only qualification being that we doubt whether the readout visibility is quite good enough for outdoor use in bright sunlight. This is a common failing with gas-discharge and LED displays, of course, and can only be obviated at present by the use of a liquid-crystal readout. Until a unit with such a readout appears, it will be necessary to use a sunshade.

Price of the Zetachron Pro II is $185.00 plus sales tax. All enquiries should be directed to Australian Time Equipment Pty Ltd, 192 Princes Highway, Arncliffe, NSW. (G.S.)

NEW PRODUCTS

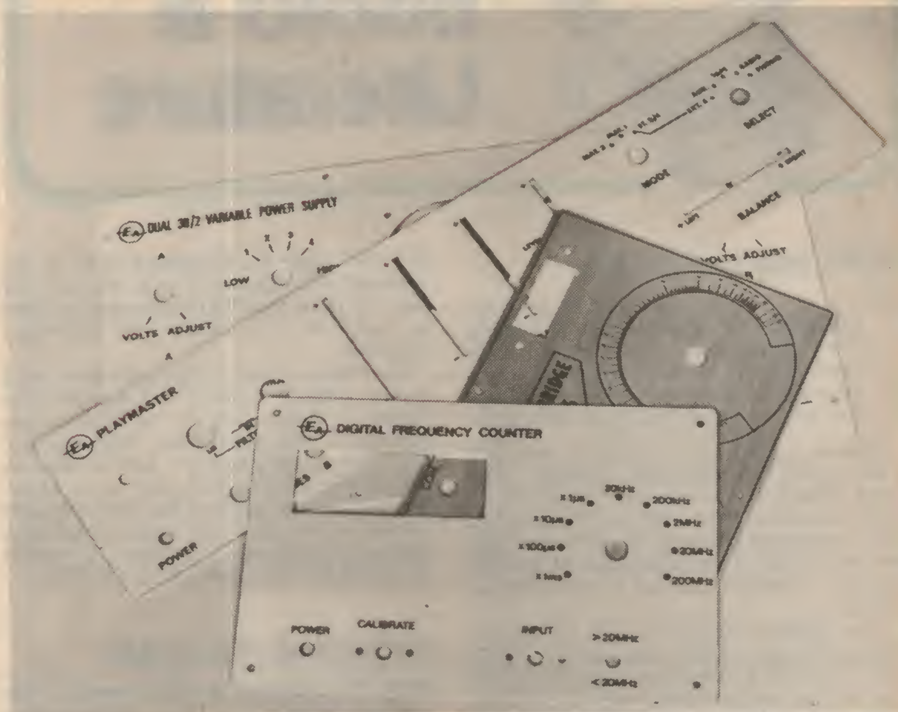
Arlunya pattern generator

Arlunya Pty Ltd has released an extremely versatile, portable, battery operated, solid state, test pattern generator specifically designed for carrying out dynamic and static convergence, grey scale tracking, and purity alignment in PAL colour receivers.

Designated the Arlunya PG11, the new unit provides five basic patterns: crosshatch, staircase, white raster, and vertical bars. Its low cost, small size and rugged construction make it an ideal instrument for service organisations involved in the installation of new receivers and general outside service work.

The Arlunya PG11 is fully designed and manufactured in Australia to meet the relevant CCIR standards and the specifications laid down by the Australian Broadcasting Control Board. For further information contact Arlunya Pty Ltd, PO Box 113, Balwyn, Victoria 3103.

Photo-etched panels for EA projects



Pictured above is a selection of photo-etched front panels for several recent EA projects as sent to us for inspection by the manufacturer, Wardrope and Carroll Fabrications Pty Ltd, PO Box 330, Caringbah, NSW 2229.

Included in the selection are panels for the 200MHz Digital Frequency Meter (December 1973), the Compact RC Bridge (March 1974), the Playmaster 140 Quadraphonic Amplifier (December 1973 to March 1974), and the Dual 30/2 Variable Power Supply (March 1974).

All panels are attractively finished, and should add a professional touch to any of the above listed projects.

Books & Literature

HiFi buyers guide

HIFI YEAR BOOK, 1974. Edited by Colin Sproxton and published by IPC Electrical-Electronic Year Books Ltd, London. Hard covers, 512 pages 210 x 132mm, including many illustrations and advertisements. Price in Australia $4.80.

Issued annually as a spin-off from the "Electrical and Electronic Trader," this book would be a treasure trove of information for high fidelity enthusiasts in the UK. It contains pictures, specifications and prices of most of the equipment on the UK market — and that adds up to a lot of equipment!

The product directory takes up all but about 35 pages of the book and is divided into about 30 sub-sections, including 3 on record players and accessories, 2 on tuners, 8 on tape systems and accessories, 3 on loudspeaker equipment, plus sundry others on amplifiers, complete systems, microphones, headphones, cabinet work, UK hifi dealers, and so on.

In Australia, the value of the book would be limited, because prices would not apply and the range of equipment here is not identical with that in the UK. But, for all that, the book does find ready sale to those to whom it is a handy and up-to-date reference.

As a bonus, there are four articles by well known writers: "Stereo FM Beyond The Fringe," "Developments in Tuner / Amplifiers," "Bargains for Beginners," "Whither Quadraphony?" Add to these a listing of current audio books, a list of abbreviations and you have the 1974 edition of a hardy hifi annual. Our copy came from Technical Book and Magazine Co, 289-299 Swanston St, Melbourne 3000. (W.N.W.)

Listening manuals

HOW TO LISTEN TO THE WORLD, 8th edition, edited by J. Frost. Published by the World Radio Handbook Ltd, Denmark.

WORLD RADIO & TV HANDBOOK 1974, edited by J. Frost. Published by the World Radio and TV Handbook Ltd, Denmark.

Further copies of these books, which were reviewed in the April issue, have been received from the Technical Book and Magazine Company Pty Ltd, of 289-299 Swanston Street, Melbourne. This firm advises that they can supply the books at $4.95 plus 40c postage and $5.95 plus 65c postage, respectively.

Electromagnetism

ELECTRICITY AND MAGNETISM, second edition, by W. J. Duffin. Published by McGraw-Hill Book Company, London, 1973. Soft covers, 210 x 235mm, 422pp, many circuits and diagrams. Price in Australia $9.40.

An introductory text on electromagnetism, written primarily for the junior-year physics and engineering student at university or college. It begins with elementary magnetism and electrostatics, and methodically progresses from these to conclude with Maxwell's equations and electro-magnetic measurements and standards. The author is a lecturer at the University of Hull, UK.

The scope of the contents may be judged from the chapter headings: 1 — Electric Charge and Current; 2— The Law of Force between Charges in Vacuo; 3 — Electric Field Strength and Potential; 4 — Further Electrostatic Methods and Problems; 5 — Capacitance and Electrical Energy; 6 — Steady Electric Currents; 7 — Magnetic Fields and Magnetic Dipoles; 8 — Forces between Steady Currents in Vacuo; 9 — Electromagnetic Induction, Inductance and Magnetic Energy; 10 — Varying Currents in Linear Networks; 11 — The Motion of Charged Particles in Electric and Magnetic Fields; 12 — Conduction; 13 — Dielectric Materials; 14 — Magnetic Materials; 15 — Maxwell's Equations and Electromagnetic Waves; 16 — Electromagnetic Measurements, Standards and Units.

The text of the book is written in very clear and concise language, and presents the subject material in a very logical fashion. It is well served by illustrations, and should therefore be found particularly suitable as a text for lecture courses or private study. The backfround assumed is basically that of high school physics and maths. The tuitional value is enhanced by problems given at the end of each chapter, answers for which are given at the end of the book together with a list of references and a topic index. There are also short commentaries on incidental topics distributed throughout the text, another worthwhile feature.

In short, a very worthy volume.

The review copy came from the local office of the publisher, who advises that copies should be available from all major and technical bookstores. (J.R.)

Buyers' guide

THE WHAT, WHERE, WHO HASSLES & HOW MUCH BOOK, by Roger and Valrie Harrison. Published by Amateur Communications Advancements, Sydney, 1974. Soft covers, 21 x 30 cm, 56pp. Price in Australia $1.50 plus 25c post and packing.

A locally produced buyers' guide, aimed at providing most of the information that radio amateurs and other electronics enthusiasts may need concerning the suppliers of electronic parts and associated materials. It is from the same stable as the monthly VHF radio amateur publication "6-UP", and is printed in the same format.

Considering its modest size, the contents are surprisingly comprehensive. And although the self-conscious "alternative culture" style evident in 6-UP is still detectable, the WWWH&H Book is very much an objective, practical and consumer orientated publication. It should be of value to anyone in electronics, whether amateur or professional, "alternative culture" or conservative.

In short, well worth having in these days of component shortages.

The review copy came from the publisher at 47 Ballast Road, Birchgrove, NSW 2041, from whom readers may order copies. (J.R.)

Motor control

POWER ELECTRONICS: Thyristor controlled power for electric motors, by R. S. Ramshaw. Published by Chapman and Hall Ltd, London, 1973. Hard covers, 160 x 240mm, 213pp, many circuits and diagrams. Price in Australia $13.50.

A fairly specialised book, as its title implies, written mainly for senior undergraduate students, graduates and practising engineers wishing to update their knowledge in this area. The author is

Associate Professor in Electrical Engineering at the University of Waterloo, Ontario, Canada.

The scope of the book is shown fairly clearly by the chapter headings: 1 — Power Electronics and Rotating Electric Drives; 2 — The Thyristor; 3 — Induction Motor Control; 4 — Direct Current Motor Control; 5 — Synchronous Motor Control. The book ends with design appendices dealing with control circuitry logic, and an index.

The text is written in concise language and is well served by illustrations. It should be found very suitable as a text for either formal or self tuition, and is in every way a worthy addition to the Chapman and Hall "Modern Electrical Studies" series.

The review copy came from the local agents for Chapman and Hall, Hicks Smith and Sons Pty Ltd, who advise that copies should be available from all major bookstores (J.R.)

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24 Solid State Volt Reg.
25 Car Theft Alarm System.
26 Ignition Analyser & Tachometer Unit.
27 Strobe Adaptor for Ignition Analyser.
28 Car Burglar Alarm.
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59 Meterless Voltmeter.
60 Wide Range Voltmeter.
61 F.E.T. D.C.
62 1966 V.T.V.M.
63 1968 Solid State V.O.M.
64 1973 Digital V.O.M. (1).
65. 1973 Digital V.O.M. (2).
66 High Linearity A.C. Millivoltmeter.
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82 1972 IC Unit (E/T).
83 Simple 5V 1A Unit.
84 Simple 3-6V 3.5A Unit.
85 S/C Proof 0-30 VDC at 1A.
86 Reg 0-30VDC at 3A O/L Protected.
87 Variable Reg 12V-05A.
88 Reg O/Load & S/C Protection 60 VDC at 2A (1973) — EA.
89 —
90 —

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91 Solid State Test Osc.
92 Signal Injector & R/C Bridge.
93 Solid State Dip Osc.
94 "Q" Meter.
95 Laser Unit.
96 Digital Freq Meter 200KHz.
97 Digital Freq Meter 70MHz.
98 IF Alignment Osc.
99 27MHz Field Strength Meter.
100 100KHz Crystal Cal.
101 1MHz Crystal Cal.
102 Solid State Dip Osc.
103 V.H.F. Dip Osc.
104 V.H.F Powermatch.
105 V.H.F. F/S Detector.
106 S.W.R. Reflectometer.
107 R.F. Impedance Bridge.
108 Signal Injector.
109 1972 FET Dipper.
110 Digital Freq Meter.
111 Simple Logic Probe.
112 Frequency Counter & DVM Adaptor.
113 Improved Logic Probe.
114 Digital Logic Trainer.
115 Digital Scaler/Preamp.
116 Digital Pulser Probe.
117 Antenna Noise Bridge.
118 Solid State Signal Tracer.
119 1973 Signal Injector.
120 Silicon Diode Sweep Gen.

TRAIN CONTROL UNITS
124 Model Control 1967.
125 Model Control with Simulated Inertia.
126 Hi-Power unit 1968.
127 Power Supply Unit.
128 SCR-PUT Unit 1971.
129 SCR-PUT Unit with Simulated Inertia 1971.
130 Electronic Steam Whistle.
131 Electronic Chuffer.

TV INSTRUMENTS
134 Silicon Diode Sweep Gen.
135 Silicon Diode Noise Gen.
136 Transistor Pattern Gen.
137 TV Synch & Pattern Gen.

VOLTAGE/CURRENT CONTROL UNITS
142 Auto Light Control.
143 Bright/Dim Unit 1971.
144 S.C.R. Speed Controller.
145 Fluorescent light Dimmer.
146 Autodim-Triac 6 Amp.
147 Vari-Light 1973.
148 Stage, etc. Autodimmer 2KW.
149 Auto Dimmer 4 & 6KW.

RECEIVERS — TRANSMITTERS — CONVERTERS
153 3 Band 2 Valve.
154 3 Band 3 Valve.
155 1967 All Wave 2.
156 1967 All Wave 3.
157 1967 All Wave 4.
158 1967 All Wave 5.
159 1967 All Wave 6.
160 1967 All Wave 7.
161 Solid State FET 3 B/C
162 Solid State FET 3 S/W
163 240 Communications RX.
164 27 MHz Radio Control RX.
165 All Wave IC2.
166 Fremodyne 4-1970.
167 Fremodyne 4-1970. R.F. Section Only.
168 110 Communications RX.
169 160 Communications RX.
170 3 Band Preselector.
171 Radio Control Line RX.
172 Deltahet MK2 Solid. State Communications RX.
173 Interstate 1 Transistor. Receiver.
174 Crystal Locked H.F. RX.
175 E/A 130 Receiver
176 E.A. 138 Tuner Receiver.
177 Ferranti IC Receiver.
178 Ferranti IC Rec/Amp.
179 7 Transistor Rec.
180 —
181 —

TRANSMITTERS
182 52MHz AM.
183 52MHz Handset.
184 144MHz Handset.

CONVERTERS
187 MOSFET 52MHz.
188 2-6 MHz.
189 6-19 MHz.
190 V.H.F.
191 Crystal Locked HF & VHF.

AMPLIFIERS PREAMPS & CONTROL UNITS MONAURAL
194 Mullard 3-3.
195 Modular 5-10 & 25 Watt.

STEREO
196 1972 PM 129 3 Watt.
197 Philips Twin 10-10W.
198 PM 10 + 10W.
199 PM 128-1970.
200 PM 132-1971.
201 ETI-425 Amp & Preamp.
202 ETI-425 Complete System.
203 ETI-416 Amp.
204 PM 136 Amp 1972.
205 PM 137 Amp 1973.

GUITAR UNITS
209 P/M 125 50W.
210 E/T 100 100W.
211 P/M 134 21W.
212 P/M 138 20W.
213 Modular 200W.
214 Reverb Unit.
215 Waa-Waa Unit.
216 Fuzz Box.

PUBLIC ADDRESS UNITS
219 Loud Hailer Unit.
220 P.A. Amp & Mixer.
221 P/M 135 12W.
222 Modular 25W.
223 Modular 50W.

CONTROL UNITS
225 P/M 112.
226 P/M 120.
227 P/M 127.

MIXER UNITS
229 FET 4 Channel.
230 ETI Master Mixer.
231 Simple 3 Channel.

TUNER UNITS
232 P/M 122
233 P/M 123.
234 P/M 138.
235 Simple B/C.

PREAMPLIFIERS
237 Silicon Mono.
238 Silicon Stereo.
239 FET Mono.
240 Dynamic Mic Mono.
241 Dynamic Mic Stereo.
242 P/M 115 Stereo.
243 —

MISCELLANEOUS KITS
244 Geiger Counter.
245 Direct Reading Impedance Meter.
246 —
247 Electronic Anemometer.
248 Simple Proximity Alarm.
249 Pipe & Wiring Locator.
250 Resonance Meter.
251 Electric Fence.
252 Metronome Ace Beat.
253 Transistor Test Set.
254 Electronic Thermometer.
255 Flasher Unit.
256 Lie Detector.
257 Metal Locator.
258 Stroboscope Unit.
259 Electronic Canary.
260 240V Lamp Flasher.
261 Electronic Siren.
262 Probe Capacitance Meter.
263 Moisture Alarm.
264 AC Line Filter.
265 Proximity Switch.
266 Silicon Probe Electronic Thermometer.
267 Transistor/FET Tester.
268 Touch Alarm.
269 Intercomm Unit.
270 Light Operated Switch.
271 Audio/Visual Metronome.
272 Capacitance Leakage Checker.
273 Audio Continuity Checker.
274 Bongo Drums.
275 Simple Metal Locator.
276 Keyless Organ
277 Musicolour.
278 Stereo H/Phone. Adapter.
279 Attack/Decay Unit.
280 Tape Recorder Vox Relay.
281 Tape Slide Synchroniser.
282 Tape Actuated Relay.
283 Auto Drums.
284 IC Vol Compressor.
285 Audio Attenuator.
286 Thermocouple Meter.
287 Door Monitor.
288 Earth "R" Meter.
289 Shorted Turns Tester.
290 Zenor Diode Tester.
291 Morse Code Osc.
292 Simple Electronic Organ.
293 Pollution & Gas Analyser.
294 Universal H/Phone Adaptor.
295 Super Stereo ETI-410.
296 "Q" Multiplier.

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The Amateur Bands

by Pierce Healy, VK2APQ

Progress in Communications

Progress in international communication techniques, plus the vast organisation behind them, the problems which have to be solved, and the plans for future development, provide much food for thought.

Some very interesting facts relating to international and national communication systems are contained in an article received from Mr R. E. Butler, ITU Deputy Secretary General. The article deals with the effective development of world-wide communication techniques. Points extracted from it will be of both general interest, and of particular interest to amateurs.

The far-reaching effects the early telegraph services have had on our way of life may not be fully realised by the man in the street. As amateurs we are probably more attuned to the changes that have taken place. However, in general, landline, radio, satellite and other current means of communication are taken for granted.

The enormous difficulties in obtaining worldwide collaboration and agreement in order that international systems may operate smoothly, are the problems faced by the ITU.

The ITU is the acknowledged international forum for the evolution, establishment, and regulation of international communications.

The history of the ITU records the evolution of: telegraph to telex; telephone from manual to fully automatic subscriber dialling; satellite in geostationary orbit; the utilisation of the radio spectrum in all of the diverse uses; cable systems (submarine, co-axial and land based); the application of computer technology to tele-communications.

Each and every one of these technological developments has meant a re-appraisal covering its integration, investment, cost benefits and social implications.

There are 32 major groups within the ITU organisation, examining questions of importance in all aspects of telecommunications, adapting tomorrow's possibilities with existing operational investments, services, regulations, and standards for development.

The ITU has foreseen a series of regulatory conferences over the next five years:

— A low frequency and medium frequency broadcasting conference for Europe, Africa, Asia and Oceania. Planning agreements covering the use of these bands for reception through low cost receivers is overdue.

— A world planning conference concerning the higher frequency bands, already designated for sharing by mobile and conventional point-to-point terrestial services with satellite and terrestial television services. Also, the introduction of direct television reception in the home via satellites.

— The planning of aeronautical radio communications of large sub-sonic and supersonic aircraft.

— A maritime regulatory conference to deal with the detailed planning needs for ship-to-shore requirements.

— In 1979, there will be a general overview and planning of new frequency bands, and perhaps some reallocation in the radio spectrum, to ensure maximum utilisation and interference free operation of all systems.

Although the ITU is concerned principally with international telecommunications, one does not have to probe deeply to see repercussions of its work on the national telecommunication systems, which are obliged to conform to definitive agreements, treaties, recommendations or instructions.

Perhaps the most spectacular developments in the present telecommunication decade have been the introduction of active communication satellites, the growth of data transmission, and the evolution of digital communications.

The application of satellite techniques has brought new dimensions to such things as: world weather watch; promising improvements in maritime and aeronautical navigation; and, within the next decade, the planning and launching of satellites for direct broadcast television.

Likewise, consider the development of computers. It is estimated that the growth of data transmission in some parts of the world will increase twelvefold over the next decade.

Less spectacular, but of tremendous significance is the evolution of digital communication. Long-term, this seems to be the shape of the communication networks of the future.

"All types of information, be it the spoken word, the television picture, the telegraph or telex recorded message, or the output of the computer itself, can be expressed in digital form for manipulation and transmission.

"The enhanced capacity of future digital networks will have repercussions which will be felt by each and every one of us.

"The proliferation of large scale data communication has a social significance. For example, the extent to which data provided for a given purpose should be available to commercial or government interests, to further other investigations or studies, raises complex legal aspects.

"In the next decade, societies face important and difficult decisions in connection with the development of telecommunication policy."

Food for thought? I think so.

A thought which came to mind is that, in the changes predicted, there are some aspects which will affect amateur radio. Is there a challenge to be met? Are there new areas for amateur experimentation? What can the amateur contribute to the communications systems of the future?

REGION III

The next meeting of the International Amateur Radio Union, Region III Association, will be held at Hong Kong in mid 1975.

The WIA delegate will be Dr David Wardlaw, VK3ADW, Federal President of the WIA. Dr Wardlaw's appointment was made at the Federal Convention of the WIA in Sydney at Easter, 1974.

David Rankin, VK3QV is Secretary General of the IARU Region III Association. That appointment is made by the association directors.

Australia

The 38th Federal Convention of the WIA was held at the Auburn Motor Inn, Sydney, at Easter, 1974. Delegates from all states and the Australian Capital Territory attended.

A major decision was the formal admittance of the recently incorporated "VK1 Division WIA" as a member of the WIA federal body. This decision now brings the number of members of the WIA federal body to seven.

Among matters discussed were:

—proportional voting by divisions on specified matters.
—increase in payments to the federal body.
—illegal operation on 27MHz and other frequencies.
—Youth Radio Club Scheme matters.
—subscription to IARU fund raised from 5 cents to 10 cents per member.

Members elected to the WIA federal executive are: President — Dr D. Wardlaw; Vice-president — J. Martin; executive members — D. Rankin, K. Roget, P. Wolfendon.

The next annual convention is scheduled to be held in Victoria on 25th, 26th, 27th April, 1975.

NSW Division, WIA

The annual general meeting of the NSW Division was held on Friday night, 26th April, 1974. In addition to the president's report, reports were received from various branches, clubs, groups and committees.

The audited treasurer's report was received and adopted. The finances of the division are in a satisfactory condition although there has been a decrease in membership.

Only four nominations were received for a council of seven. On a point of order relating to article 22 of the constitution ("The quorum of council shall be five") being raised, the chairman ruled that election of council be held over until the legal officer could be consulted.

A motion dealing with the appointment of a NSW YRCS education officer was discussed at length and the matter passed to council for action.

LOCAL AND OVERSEAS NEWS

432MHz Moonbounce Record

A record 432MHz two-way contact was established at the end of March, 1974, by the Illawarra Branch moonbounce group co-ordinator Lyle Patison, VK2ALU, assisted by Charlie Proctor, VK2ZEN; Roger Evans, VK2BRE and Hank Laauw, VK2BHL.

E-M-E contacts were made on the 30th and 31st March between VK2AMW, Dapto, NSW, and G3LTF in Essex, England. This eclipses the previous 432MHz E-M-E record with K2UYH, by a significant but yet uncalculated distance. Signals from G3LTF were 6dB above the noise.

Previously G3LTF had worked only K2UYH New Jersey, USA, and VE7BBG, British Columbia, Canada, on 432MHz. A power of 800 watts to a 5 metre dish antenna was used for the tests with VK2AMW, where the power was 500 watts into a 9 metre parabolic reflector.

During tests over the same weekend with US stations only one station, W1SL, was heard on the 30th March, and K2UYH was worked on the 31st using CW.

Amateur Satellite News

Here are some interesting snips from the March, 1974, AMSAT Newsletter.

March 3rd, 1974, was the fifth birthday of the formation of the Radio Amateur Satellite Corporation (AMSAT). A membership growth from a handful in 1969 to over 1100 in some 52 countries was realised in those five years.

AMSAT—OSCAR 6 has been in operation for nearly 18 months; OSCAR 7 is well advanced and may be called up for launch in July, 1974.

AMSAT directors considered various possible follow-on satellite programs:

1. Low polar orbit.
2. Medium attitude polar or inclined orbit.
3. Geosynchronous.

These possibilities will be further explored and discussed with responsible authorities.

Following discussion on the 1974 budget, approval was given by the directors to proceed with the budget of $US85,000.

The idea to provide a fifteen-to-ten meter linear repeater has been tabled for the present.

It has been agreed that specifications for an analog telemetry system be prepared. Such a system would provide data on functions which vary rapidly with time.

It is reported that approximately 2000 stations have made over 100,000 two-way contacts through OSCAR 6. Over 25,000 contacts have been on SSB and many on RTTY and slow scan TV.

The purpose and objective of AMSAT is:

"To provide satellites that can be used for amateur radio communication and experimentation by suitably equipped amateur radio stations throughout the world on a non-discriminatory basis."

Membership of AMSAT is open to all amateurs. Address applications to: Radio Amateur Satellite Corporation, PO Box 27, Washington, DC 20044 USA.

Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent direct to Pierce Healy at 69 Taylor Street, Bankstown, 2200.

AMATEUR BANDS

Australian Awards

Several awards, sponsored by the WIA, are available to Australian and overseas amateurs. Full details from the WIA, federal awards manager, Brian Austin, VK5CA, PO Box 7A, Crafters, SA 5152. Brief details are as follows:

"Australian DX Century Club Award" — available to any Australian amateur who confirms contact with 100 or more different countries on the high frequency bands.

"Australian VHF-UHF Century Club Award" — available to any Australian amateur who confirms contact with 100 or more different stations on any single VHF-UHF band between 52MHz and 2450MHz.

"Worked all States VHF Award" — available to any amateur who confirms contact with each call area VK1-VK8 on either 52MHz or 144MHz band.

"Worked all VK Call Areas Award" — available to any overseas amateur who confirms contact with the required number of Australian stations in the call areas VK1-VK0 on the high frequency bands.

"Worked all VK Call Areas (VHF) Award" — available to any amateur who confirms contact with the required number of Australian stations in the call areas VK1-VK0 on the VHF bands.

Field Day Contest

Comments by participants in the 1974 "John Moyle Memorial National Field Day Contest" sponsored by the WIA, indicate that it was an enjoyable and friendly event. The scores showed a high degree of activity, both in the 6 hour and 24 hour sections. Below are the highest scorers in each section from each call area.

24 hour division — Transmitting phone: VK3AUQ 1162; VK41E 2375. Transmitting CW: VK3ANU 1154. Transmitting open: VK2RJ 1686.

24 hour — Multiple operator, transmitting open: VK1ACA 6288, 12 operators; VK2WG 2334, 9 operators; VK3APC 5742, 13 operators; VK4WIT 2731, 19 operators; VK8DA 2619, 8 operators.

24 hour — Multiple operator, transmitting phone: VK3ANR 703, 2 operators; VK5LW 1989, 9 operators; VK9XI 625, 3 operators. Transmitting VHF: VK2YAV626: VK3AVJ619: VK6ZIW 126.

24 hour — Transmitting home station: VK2RX 330; VK3AYL 975; VK5ZT 850. Receiving section: K. D. Cunningham 850.

6 hour division — Transmitting phone: VK1JG 320; VK3BBC 940; VK4GT 877; VK5BW 814; VK7AX 560. Transmitting CW: VK2YB 324, VK3TX 255.

Transmitting phone, multiple operator: VK3JH 913, 3 operators; VK3BDQ 834, 3 operators. Transmitting VHF: VK2PN 272; VK5BW 54; VK3ZAE 34.

Transmitting, home station: VK2ZA 250; VK4UJ 225; VK3QK 845; VK5LM 555. Receiving section: S. Gillespie 1600; P. J. Hall 710; A. J. Everett 400; E. Trebilcock 390 CW only.

Worthwhile Certificates

In recent months, these notes have included details of two organisations for amateurs who collect certificates or awards. However, there is a very worthwhile certificate available to Australian amateurs, which would not qualify for recognition by either organisation.

Maybe the requirements for the certificate are too time consuming, when compared with others relatively easy to obtain. But the feeling of achievement could be far more rewarding and lasting.

The certificate referred to is the WIA Youth Radio Club Scheme — Radio Instructor's Certificate. The requirements are summarised as follows:—

There are three grades, each requiring that the applicant—

a. must have undertaken the duties of radio instructor preparing candidates for YRCS-Radio Proficiency Certificates and / or for Amateur Operator Certificate of Proficiency.

b. must be recommended in writing by the YRCS state supervisor for the award of the certificate.

c. must submit sufficient successful candidates to earn the following points: Grade 3 — 25 points; Grade 2 — 75 points; Grade 1 — 175 points.

Points schedule based on YRCS certificates:

a. Elementary radio certificate stage 1	1 point
b. Elementary radio certificate stage 2	2 points
c. Junior radio certificate stage 1	3 points
d. Junior radio certificate stage 2	5 points
e. Intermediate radio certificate stage 1	7 points
f. Intermediate radio certificate stage 2	9 points
g. Senior radio certificate	11 points
h. Advanced radio certificate	13 points
i. Radio telephony operator's certificate	7 points
j. Wireless telegraphy operator's certificate	9 points
k. Short-wave listener's certificate grade 3	1 point
l. Short-wave listener's certificate grade 2	2 points
m. Short-wave listener's certificate grade 1	4 points

Based on PMG's Department examinations:

a. Novice licence theory	9 points

b. Novice licence Morse code 4 points
c. AOCP theory 15 points
d. AOCP Morse code 8 points
e. PMG's Department regulations (AOCP) 5 points

Maybe, local representatives of both organisations and the YRCS might get together and work out a form of recognition, to their mutual benefit.

Anyway, whether a collector of certificates or not, what about trying for the YRCS — Radio Instructor's certificate?

How to start accumulating the necessary points? Contact the YRCS supervisor in your State — NSW, VK2BLW; Victoria, VK3BAN; South Australia, VK5FD; Queensland, VK4CA; Western Australia, VK6H; Tasmania, VK7KK.

RADIO CLUB NEWS

Central Coast Amateur Radio Club

To assist members to get the best out of their two metre mobile units, the Central Coast Amateur Radio Club is arranging a servicing clinic to be held at the club rooms, Dandaloo Street, Kariong, on Sunday, 30th June, 1974. It is expected that Peter Campbell, VK2AXJ, who is very experienced in this type of servicing clinic, will be in attendance. It is emphasised that units must be in working condition.

A group at the Woy Woy High School is interested in radio and electronics. Ted Garnett would like to hear from someone who would give a talk on the subject for an hour or so some Wednesday afternoon. If you could assist, Ted's address is 2 Myall Street, Ettalong.

Discussion among club members on the February field day has brought forth several constructive ideas. These are aimed to further improve what is now the biggest amateur radio field day in Australia.

The CCARC repeater, VK2RAG, provides excellent coverage for two metre mobiles operating in the Central Coast area. Recently the receiver was serviced and 18 valves were replaced.

Ray Wells, VK2ZSX, has been appointed WICEN officer for the Central Coast area, following the retirement of Vaughan Wilson, VK2VW, from the position.

For information on the CCARC write to the secretary, Barry Gibbins, VK2ZUX, PO Box 238, Gosford, NSW 2250.

Illawarra Branch

After considerable work on the unit, the Illawarra Branch Channel 1 repeater has been re-installed at the site near Robertson. Reports are that the unit is now operating satisfactorily. A working bee also carried out maintenance work on the cubicle and mast.

A special invitation is extended to all amateurs in the Wollongong area to come to the meetings and join in the branch activities. Meetings are held in the committee room, Wollongong Town Hall, on the second Monday of each month at 7.30 pm. Visitors are welcome.

Westlakes Radio Club

Elementary, Junior and Intermediate classes for YRCS certificates are held at the Westlakes Radio Club each Saturday afternoon commencing at 1.00 pm.

Despite the very wet weather in March and April members have pressed on with the new club premises. However, the weather has delayed the extensions and other outside work.

Eric Brockbank, VK2ZOP, secretary, will be pleased to give any information on club activities. Write to PO Box 1, Teralba, NSW 2284.

Maitland Radio Club

The first member of the Maitland Radio Club to gain the Bronze Medal in the Duke of Edinburgh Award through his success in YRCS certificate examinations is Chris Duggan of Newcastle. It is reported that Chris is now progressing well on the way for the Silver Medal.

The Maitland Radio Club exhibit at the 1974 Maitland Show was an outstanding success. From the fine stand and studio built by the Show Society for the club, assistance was provided to the Show Society, Maitland Police, exhibitors and showmen through the MRC public address system.

The president of the Maitland Show Society, Dr R. H. K. McKerihan, when presenting the Junior Farmers awards in the Rural Youth Pavilion, praised the Maitland Radio Club for the job it is doing.

Over 200 persons attended the first field day held by the MRC. The event, at the club headquarters in Maize Street, East Maitland, was an outstanding success.

Visitors are always welcome. Full information on all MRC activities may be obtained from the Secretary, MRC, PO Box 59, East Maitland, NSW 2323.

University of NSW Amateur Radio Society

The Annual General meeting of the University of NSW Amateur Radio Society was held on 30th March, 1974, in the Shalom College. Officers elected were:

President, Samson Voron VK2BVS. Vice-president, Steven Blair VK2ZFF. Secretary, Frank Sobora. Treasurer, George Chenouda. Organisers, Maurice Alafaci VK2YBF, Kenneth Cooke. YRCS Liaison officer, Daryll Horsfall. Puplicity officer, Thomas King WA7DPO / VK2.

The meeting decided that the UNSWARS affiliate with the WIA; the WIA Youth Radio Club Scheme, and the American Radio Relay League.

During orientation week 1974, at the University of NSW, the society manned a display continuously from 9.00 am to 5.00 pm, demonstrating amateur radio. The society's station, VK2BUV, made contacts with amateur stations in the USA, Japan and New Zealand. As the result of the display 20 students joined the society.

Approval has been given for the society's station VK2BUV to be set up in room 601 on the top floor of the electrical engineering building.

A request has been made, through the Students' Union, to the Universities August Grants Committee for funds to purchase a FT101B transceiver, a TH6DX antenna and a SWR meter.

Morse code classes are held twice weekly, Monday and Friday, at the Shalom College, University of NSW. For information contact Bruce Howard, VK2BHW, 16 Primula Street, Lindfield 2070, telephone 46 4568.

The society's postal address is: University of NSW Amateur Radio Society, Union Box 57, PO Box 1, Kensington 2053.

West Australian VHF Group

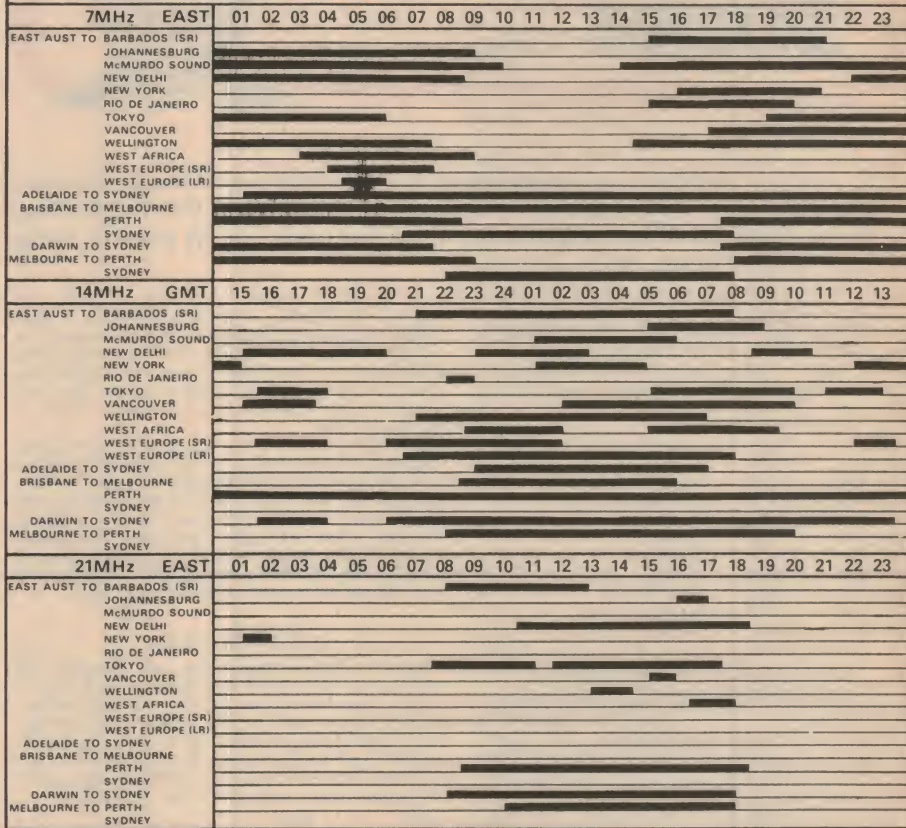
At a recent West Australian VHF Group meeting it was suggested that the group undertake a tracking exercise on the OSCAR 7 satellite scheduled for launch during 1974, using the satellite beacon on 2300MHz. Purpose of the exercise would be to obtain publicity for amateur radio and give members a chance to try something new, as was done with the previous amateur satellites. The project, it is said, "... will be a real challenge".

The hamfest over the long weekend in March at Albany, organised by the Southern Electronics Radio Club, was most successful. The catering effort by the Albany group was first class and the organisation excellent. Thirty car loads of amateurs, their wives and families, enjoyed themselves.

Apart from one field event on 146MHz, the weekend was devoted to sightseeing and social gatherings. As a token of appreciation the visitors made a presentation of $32 to the club towards the cost of VHF beacons and repeater installations in the area.

IONOSPHERIC PREDICTIONS FOR JUNE

Reproduced below are radio propagation graphs based on information supplied by the Ionospheric Prediction Service Division of the Commonwealth Bureau of Meteorology. The graphs are based on the limits set by the MUF (Maximum Usable Frequency) and the ALF (Absorption Limiting Frequency). Black bands indicate periods when circuit is open. 6.74



WIA YOUTH RADIO SCHEME

Figures given in the annual report of the WIA Youth Radio Club Scheme by Federal Co-ordinator, Reverend Bob Guthberlet, show that there were 73 clubs and 20 correspondence groups registered with the scheme, with a total membership of 1200. Voluntary instructors number 125.

Certificates issued at the various levels were:— Elementary — 377; Junior — 194; Intermediate — 37; Senior — 14; Advanced — 4 and Radio telephony — 2. In addition there were 6 Radio Instructor's certificates issued, 6 students gained the PMG Department's AOCP and 10 gained the AOLCP.

A conference of YRCS supervisors from all states will be held at Maitland, NSW, on the 31st August and 1st September, 1974. The venue will be the Maitland Radio Club. Among matters to be discussed will be the YRCS constitution and the revision of syllabus for YRCS certificate courses.

Shortwave Scene

by Arthur Cushen, MBE

The Voice of Germany has established a relay base on Malta to improve reception of their MW and SW broadcasts to Asia, Africa, the Middle East, and the Americas. Transmissions from the new relay are at present being carried out on a test basis.

Located at Cyclops, the new installation on Malta has one medium-wave transmitter and three shortwave transmitters each of 250kW. The medium-wave transmitter has been testing on 1570kHz, and the short-wave outlets have been assigned a tentative test schedule.

The tentative schedule is:

GMT	kHz	Area
0200-0615	11865	North South America
0630-0700	11850	East Africa
0700-0910	15245	Australasia
0830-0900	17780	Middle East
0900-1115	17825	Japan
1130-1230	15235	USSR
1315-1430	21650	China
1430-1515	11785	Middle East
1515-1745	17875	India
2300-0115	15225	South America

NEW ZEALAND'S NEW SLOGAN

"Radio New Zealand" is no longet the slogan of the short-wave service of the New Zealand Broadcasting Corporation. Due to a recent change in the Broadcasting set-up in New Zealand, with radio and two television networks now being operated as separate functions, the radio network has taken over the title of "Radio New Zealand." From now on the short-wave service is identifying as "The External Services Division of the NZBC". The station is also announcing as "This is New Zealand Calling".

CHILE EXPANDS SERVICE

According to a letter from the Voice of Chile, plans are under way to expand their services. At the present time, the station is using frequencies of 6195, 9510, 9590 and 15150kHz.

The Voice of Chile will shortly broadcast through a greater number of frequencies, will increase the power of some transmitters, and is studying the possibility of simultaneously sending its programs in two or more languages.

The program consists of a daily summary of Chilean events broadcast from Monday to Saturday from 2030GMT to 0500GMT and from 0900GMT to 1100GMT. A weekly summary of news is given on Sundays at the same times.

These programs, extending over approximately 20 minutes each, are broadcast in several languages in the following order: Arabic, Russian, German, Italian, French, English and Spanish.

HANDICAPPED AID CAMPAIGN

Radio Nederland is to issue a new verification card in honour of the World DX Handicapped Aid Campaign which this year follows up the successful World DX Friendship Year of 1973.

Many stations are helping the handicapped to gain greater enjoyment from shortwave listening by providing help in the form of equipment and special facilities, and Radio Nederland, with its DX Jukebox program, is to issue a verification card along this theme. The card will show the words "World DX Handicapped Aid Campaign" in bold type, and beneath this the equivalent in braille dots.

The writer, who uses a braille script for his DX Jukebox contribution on the first Thursday of each month, has supplied the braille system with its printed equivalent, and this should make an interesting verification. The fact that Harry van Gelder has recently undergone eye operations means that the compere of the session also has an intense interest in the handicapped.

The card also states "In 1829 a blind, 20-year-old Frenchman, Louis Braille, created a bridge between the world of his time and the sightless. In 1974, with the means of our time, DXers and DX Organisations can link the spirit of the DX Friendship Year '73 with this and future years, by bringing colour and a new interest into the lives of people isolated by whatever form of disability. Be a friend indeed and lend a helping hand in the World DX Handicapped Aid Campaign."

KGEI NOW 250kW

KGEI in San Francisco has now brought into operation its new 250kW transmitter, and is broadcasting Gospel programs for the Far East Broadcasting Company both to Latin America and the Far East. The service to Latin America is from 1700-0700GMT and the balance of the transmission is for reception in the Far East. The station has informed us of their new tentative schedule which is as follows:

GMT	kHz
1700-2300	15175
2130-2300	17720
2300-0400	15355
0400-0700	9615
0700-1430	11705
1430-1700	11820

SWEDEN CHANGES SCHEDULE

Radio Sweden commenced a service to Australia and New Zealand in November, 1969, following my visit to Stockholm and a report of the interest in this part of the world in their broadcast. Initially the service was a success, but in recent months the time of the transmission, which was from 0515 to 0615GMT in English and Swedish, plus the difficulty in finding suitable frequencies, has resulted in spasmodic reception.

The service has now been retimed, and is broadcast from 0230 to 0300GMT on 11940kHz. This new time will give good reception during our winter, but will only be of value for weekend listening. The same transmission is beamed to North America on 9725kHz. The power now being used is 350kW instead of the previous figure of 500kW which is the maximum output of the transmitters. We have suggested that the English service should commence at 0800GMT and broadcast on 9630kHz, the frequency used at 0830GMT for a transmission in Russian.

LATIN AMERICAN NEWS

VENEZUELA: A frequency change has been noted for La Voz De Fe, which was formerly on 3375kHz. The station is now using 4930kHz, and is scheduled to operate from 1000-0400GMT.

COLOMBIA: A new Colombian signal has been noted on 6170kHz around 0700GMT. The station was first noted by Chris Davis of Featherston, NZ, and our own observations have been around 0800GMT when a cuckoo clock call is heard before full station identification. The station identification is "La Voz De Silva," and it is located at Florencia, Colombia.

BRAZIL: According to the New Zealand DX Times, last November the Brazilian Government cancelled the broadcasting licences of several stations, including Radio 9 de Julio on 9620kHz and Radio America on 11855kHz. This is the first time the Federal Authorities in Brazil have exercised this legal right. The closures were due to "technical or fiscal administrative reasons," and press reports indicated "a future list of licences to be cancelled is to be published soon," and will involve a "great number of stations". At present Brazil has more than 1500 radio and 250 TV stations.

MEDIUM-WAVE NEWS

PHILIPPINES: The Far East Broadcasting Company in Manila has announced plans to install a new 250kW MW station at Iba, Zambales on Northern Luzon, to serve South East Asia. According to FEBC, the transmitter and land have already been purchased.

TAIWAN: The American Forces Taiwan Network increased power on its frequency of 1570kHz to 10kW last year. Another frequency used to relay the programs, 1590kHz, is shortly to have a power increase to 5kW. The main station of the AFTN is operating on 1550kHz, and is heard after 1600GMT at fair strength.

NEW ZEALAND: A high powered relay station to cover the Central North Island area is planned by the NZBC. The new station will operate on 540kHz and will have a power output of 20kW. According to the New Zealand DX Times, the station will use two aerial towers of around 200 metres high, and will improve the poor reception currently experienced in this area.

NORFOLK ISLAND: Radio VL2NI, which operates from Norfolk Island on 1570kHz, has been heard in New Zealand on Saturdays till after 0745GMT. A full story on this station was featured in the February issue, however it now appears that the schedule has been extended. Our reception was fair, but interference was noted from ABC stations as well as XERF.

LISTENING BRIEFS

EUROPE

HUNGARY: Radio Budapest's new transmitter of 250kW is now in operation and Bob Padula of Melbourne reports reception of a transmission on Sundays at 0800GMT on 6180kHz. The broadcast was in Greek and faded out around 0900GMT.

MONACO: Dr Ral[illegible]reed, General Director of Trans World Radio, died [illegible]ently at the age of 81. He was formerly General Director of the Voice of Tangier which began operations in 1953. In 1960 he and the station moved to Monte Carlo and the station became TWR. Our verification shows that the Voice of Tangier used only 2500W when it was established, a far cry to the Bonaire relay which uses 500kW on medium-wave and 300kW on short-wave.

AFRICA

GABON: A report in Sweden Calling DXers indicates an extension of the schedule of La Voix de la Renovation, Libreville, to 2400GMT on 4777 and 3300kHz. A frequency change to 7270kHz has also been noted in the transmission from 0630-1630GMT.

BURUNDI: The missionary station Radio Cordac in Bujumbura seems to have changed frequencies. The station has been heard with religious programs in English, French and local languages on 3340kHz.

CHAD: A newly received verification to hand from Radiodiffusion Nationale Chadienne gives a changed schedule on their verification card: Monday-Friday 0430-0630, 1130-2130; Saturday 0430-2300; Sunday 0430-2130. A frequency of 4904kHz is used in the first and last portions of the program, whilst 7120kHz is used from 1130GMT.

ASIA

BANGLADESH: The SW broadcast from Dacca to Europe is now heard from 1900-2100GMT in Bangla on 7250 and 9580kHz. A service in English is carried on the same frequencies from 1845-1900 and 2100-2200GMT. Another English transmission from 1230-1300GMT is on 15455 and 17690kHz.

MALAYSIA: Radio Sarawak has changed frequency for transmission from 1000-1500GMT and is now heard on 7270 and 4895kHz. The new frequency of 7270kHz replaces 7230kHz.

TURKEY: According to Radio Sweden, a new station operated by the Istanbul Police is now broadcasting on 6325kHz. Programs are in Turkish and mainly consist of Turkish music. The station has been heard from 0900-1000 and 1400-1500GMT.

AMERICAS

URUGUAY: According to Sweden Calling DXers the energy crisis has had its results in Uruguay, with many short-wave stations now on reduced schedule.

Radio Oriental operates with only 1kW on 11735kHz from 0730-0230GMT. Radio Carve, CXA13, on 6155kHz transmits at 1415-1515GMT. Radio Libertad Sport uses the SW transmitters of Radio El Expectador for sports broadcasts only. Radio Sur on 6000kHz, 1.2kW is on the air irregularly, but not more than two hours a day. Radio Fenix is completely inactive on SW. SODRE is operating on CXA6 on 9620kHz and CXA14 on 15270 kHz.

Further details on other stations, and information on what is being heard by readers, should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add 8 hours for WAST, 10 hours for EAST, and 12 hours for NZT.

MODEL RH-20 $20.00 Packing & Postage $1.00.

20,000 Ohms per Volt DC.
10,000 Ohms per Volt AC.
Specifications:
DC Volts: 0.25, 2.5, 10, 50, 250, 1000.
AC Volts: 10, 50, 250, 500, 1000.
DC Current, 50uA, 25mA, 250mA.
Resistance: 7K, 700K, 7M.
Decibels: —10, +22 (at AC / 10V) +20, +36 (at AC / 50V). Upper frequency limit 7KHZ.
Batteries: Two 1.5V dry cells.
Complete with test leads

MODEL RH-80 $22.00 Packing & Postage $1.00

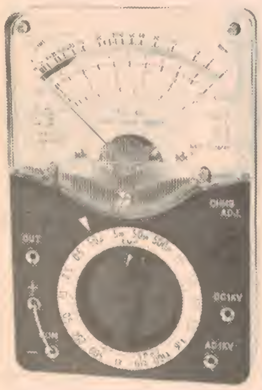
20,000 Ohms per volt DC.
10,000 Ohms per volt AC.
Specifications:
DC Volts: 0.5, 2.5, 10, 50, 250, 500, 1000.
AC Volts: 10, 50, 250, 500, 1000.
DC Current: 50uA, 5mA, 50mA, 500mA.
Resistance: 5K, 50K, 500K, 5M.
Decibels: —10dB + 62dB.
Accuracy: DC 3pc.
AC 4 per cent (of full scale).
Batteries: Two 1.5V dry cells, size AA, "Eveready" 915.

4-SPEED RECORD UNIT

"Ambassador" 4 speed 16, 33, 45 & 78 rpm stereo phono unit, complete with Ronette pickup. Stereo ceramic cartridge and stylus for LP and 78 records.
Packed ready to mount with screws and template for installation.
Instructions for connecting to amplifier or radiogram. 240V AC mains operated.
Posted NSW $16.50. Posted Interstate $17.00.
Reduced from $25.00. Special Offer.
Order now, limited stocks.

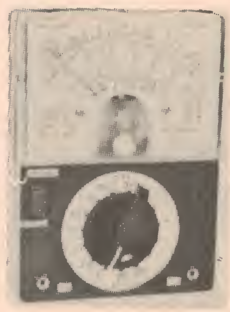
NEW RH (Radio House) RANGE OF MULTIMETERS

MODEL RH-60 $29.00 Packing & Postage $1.00



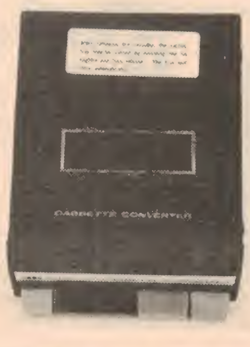
50,000 Ohms per Volt DC.
10,000 Ohms per Volt AC.
Specifications:
DC Volts: 0.25, 2.5, 10, 50, 250, 500, 1000.
AC Volts: 10, 50, 250, 500, 1000.
DC Current: 25uA, 5mA, 50mA, 500mA
Resistance: 10K, 100K, 1M, 10M.
Decibels: —10 +62dB.
Accuracy: DC ±3 p.c., AC ±4 p.c. (of full scale).
Batteries: Two 1.5V dry cells.
Overload protected.

"HANDYMAN" RH150 $14.75



CHECKED PACKED & POSTED $15.50
Pocket-size 3¼" x 4½" x 1¼".
Instruction sheet and circuit.
SPECIFICATIONS:
DC Volts: 2.5, 10, 50, 250, 1000.
10,000 ohms per volt
AC Volts: 10, 50, 250, 500, 1000.
DC Current: .1, 25, 250mA.
Resistance: 20K and 2M.
Decibels: —20dB, +62dB, 0.7KHz.
Capacitance: .0001, 01, .0025, 25uF

NEW MODEL NA — 100 CASSETTE CONVERTER



PRICE: **$35.00** Pack & Post $1.00.
Play your cassette tapes through your car Radio and speaker and save **$30.00** to **$40.00**
SIZE 6" x 4½" x 2⅛"
Complete with fittings and instructions to install in any car which has a radio fitted. Radio can also be operated when required. This model reproduces the excellence of music from a cassette through the AM Car radio. Operation is extremely simple.

WORLD RANGE SOLID STATE DELUXE RADIO / MODEL /ACE TRS / 35 /

19 TRANSISTORS — 9 Diodes — 500 MW output.
SIZE 11" x 13" x 5".

FEATURES:—
1. Tuning knob
2. Fine tuning knob
3. On-Off push Switch
4. Volume Control
5. Tone Control
6. Squelch Control
7. Band selector knob
8. Time zone
9. Telescopic antenna
10. Dial light
11. AC / DC selector
12. Extension Antenna Jack
13. Earphone Jack

This new Solid State Radio is all-band, all transistor portable designed for super sensitive reception of Amplitude Modulation (AM) Marine Band (MB) International Short Wave (SW1, SW2) Frequency Modulation (FM) Public Service Band LOW (PB), AIRCRAFT (VHF1) High Public Service Band (VHF2) and Weather Band (WB).
These Bands will provide you with many hours of entertainment and excitement. This radio is also equipped for house electricity (240 AC) as well as by batteries (4 "D" cells).
PRICE:— **$135.00** pack & post $1.50.

RADIO HOUSE PTY. LTD.

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INFORMATION CENTRE

VHF CONVERTER & BFO: I have just built a small short wave receiver covering 6MHz to 18MHz and I would like to add a simple BFO to it. Could you help me with this? Also, are indoor aerials comparable with outdoor aerials? I am interested in building the VHF converter featured in August, 1973. The article states that the converter must be used with a receiver capable of being tuned to 3MHz. I do not have a receiver for this frequency so how can I get around this problem? Can you tell me the frequencies of the fire, police, ambulance and coastal sea trawlers? I enjoy reading your magazine and the ideas and projects are excellent but why has the price risen to 75c? (A.D., Jannali, NSW.)

First off, A.D., we described a simple BFO (File No 2/BFO/2) in January, 1969, and copies of the article are available for 80c. Yes, indoor aerials are comparable with outdoor aerials, but the comparison is usually not in favour of the indoor aerial. If you wish to build the VHF converter you need a receiver tunable to 3MHz and the only way out of this dilemma is to get a suitable receiver. Perhaps you could add to your new 6-18MHz receiver to make it tune 3MHz. We are not in a position to quote the frequencies of the various services which you have requested. We are pleased to know that you like the magazine. As we explained in the May issue, the price rise to 75c was necessitated by the steeply rising costs of materials and labour. The increase was made reluctantly, but in the belief that this was preferable to reducing the size or quality of the magazine itself.

INFORMATION PLEASE: I am very interested in capacitor-discharge ignition systems. Have you published any other articles on the subject other than those in November 1969, August 1970 and November 1970?

Is the handbook "Fundamentals of Solid State" still available and what is the cost per copy and postage?

From many projects in "Electronics Australia" I find that certain capacitors are specified as NPO types. Can you please tell me the meaning of NPO?

Also, what is the purpose of RIAA equalisation in audio amplifiers and what do the letters RIAA stand for?

What are the frequencies that a dog can hear? I have been told that they can hear very high frequencies.

Finally, what are the rates of subscription and postage to Malaysia? (L.T.T., Selangor, Malaysia.)

Several other articles on CDI systems have been published. A system with a photo-electric distributor was published in September and October 1970 (File Nos 3/TI/7,8) and 6V CDI system was published in November 1971 (File No 3/TI/10). We also suggest you read the article entitled "Electronic Ignition Reconsidered" in June 1973 (File No 3/TI/11) in which we discuss some of the limitations of CDI systems.

The term NPO is applied to certain ceramic capacitors which have a zero temperature coefficient of capacitance over the range from minus 50 to plus 100 degrees Celsius. This means that the capacitance does not change with changes in temperature.

RIAA stands for Recording Industry Association of America. The RIAA recording characteristic calls for bass cut (to allow closer groove spacing) and treble boost (to override noise). RIAA equalisation in playback amplifiers calls for a complementary characteristic, ie, bass boost and treble cut. The exact details are best portrayed as frequency response graphs which have been published from time to time.

There are few references available which give exact information on animal hearing but as far as we can ascertain, dogs can hear frequencies well beyond 50kHz and perhaps up to 100kHz. However, most dog whistles operate in the vicinity of 20Khz.

The subscription rate to Malaysia for Electronics Australia by surface mail is $A10 per year. The handbook "Fundamentals of Solid State" is available at $2.00 plus 60 cents for surface mail or $1.00 airmail.

PRINTED BOARDS: Could you please advise on the purchase price and availability of printed boards for the Playmaster 140 project. (A.V., Frankston, Vic.)

Printed boards are the same as any other components, A.V. — you get them at your normal parts supplier. He is in the best position to advise you on price, which varies with the supplier.

FIBRE OPTICS: I recently saw an advert in your magazine for some Fibre Optic Kits, but have mislaid the information. Can you help? (D.R., Tauranga, NZ.)

The advertiser referred to was probably Dick Smith Electronics, of Gore Hill, NSW.

RADIO CONTROL: Have you any articles on construction of radio control units for model planes and boats? Could you recommend any books on the subject? (P.M., French's Forest, NSW.)

The only articles we have done are now considered out of date, the parts being almost impossible to obtain. The best source of information on this subject would probably be in the City of Sydney Public Library, which has a good section on electronics books.

GUITAR AMPLIFIER: Is the Playmaster 135 (September 1972) suitable for electric guitar work and are most electric guitars earthed when plugged into an earthed amplifier?

I really like the new layout of your magazine. (S.G., Sandringham, Vic.)

The Playmaster 135 is not really suitable for guitar work. For a start, the sensitivity of its first stage is too high and would be easily overloaded. Secondly, guitar users generally require full tone control facilities. Why not build the Playmaster 138 featured in May 1973 (File No 1/GA/20), which has been designed specifically for the job.

The metalwork of a guitar would normally be earthed when it is plugged into an earthed amplifier.

Thank you for the compliment on our magazine layout, which we are attempting to upgrade continuously.

APRIL FOOL: You beasts! I fell for the April printegrated circuit connived, I presume, by one "Tricky Dick". The whole rigmarole seemed almost plausible, but watch out next year: "Once bitten, twice shy" . . . or I should say "You can fool some of the people . . ." Yours, begrudgingly, etc. (M.B., Kilsyth, Vic.)

If it's any consolation, you weren't the only one. What is more, the Government Printers have had unusual demand for metric clock faces, too . . . But you won't have to worry about next year — or for some time to come. It will be quite a while before EA publishing day (first Monday in the month) again falls on the 1st April!

ELECTROPLATING: I have become interested in electroplating as I have found it nearly impossible to have done. I have seen a basic explanation, but found it most unsatisfactory and hard to follow. Would you be able to tell me which book I should try to obtain and where I could do this? I am only a beginner at plating, and I would appreciate your help very much. (J.F.B.)

The article "Plating At Home" in the August 1965 edition (File No 8/C/12) would probably give you most of the information you need. It is available from our Information Services at a cost of 80c.

PEAK AUDIO POWER: I understand that the transient peaks of program material are at least ten times the voltage level of the average signal. If the average listening level for domestic listening is 10 to 15 watts, the power on peaks would rise to 1.5kW. Perhaps this has something to do with the difference between valve tone and transistor tone. Transistor amplifiers clip very sharply on overload but a valve amp. rounds the peaks and only under very severe overload clips in the style of a transistor amplifier. (D.J., Wellington Nth, N.Z.)

We have abbreviated your letter, D.J., but retained the basic theme. Your assumption of 10-15 watts average listening power is way off the mark. With reasonably sensitive speakers in an ordinary living room, the average power per channel for much of the time would be only a fraction of a watt. On the basis of less sensitive speakers in a large room, and a generous peak/average ratio, it is possible to make a case for higher powered amplifiers — say 100 watts or more — but even that is in a different league to what most of us consider necessary. It has nothing to do with valves v transistors. For all practical purposes, a wide-range valve amplifier will overload just as sharply as a transistor amplifier, with just as obvious distortion. What differences there might have been have more to do with lack of care in the cross-over region under low-level conditions, but most designers are wide awake to this nowadays. Yes, we had noted the transposition in the channels in the Stereo-24 printed circuit adaptor and an errata note has been prepared.

RADIO & TV STATION LIST: Thank you for reintroducing the shortwave notes by Arthur Cushen. Do you intend to publish the annual list of radio and TV stations in Australia and New Zealand this year? (A.A., St Marys, SA.)

We are pleased that you appreciate the reinstatement of "Shortwave Scene". Lack of sufficient space has prevented us from publishing this year's list of radio and TV stations. However, a full list of these was published in the January 1973 (File No 8/SL/11) and February 1973 (File No 8/SL/12) issues of "Electronics Australia", and these should be up to date but for a few minor changes. Copies of these articles are available through our Information Service.

HOW TO USE OUR INFORMATION SERVICES

As a service to readers "Electronics Australia" is able to offer: (1) Project reprints, metal work dyelines, photographs, printed wiring patterns and other filed material to do with constructional projects and (2). A strictly limited degree of assistance by mail or through the columns of the magazine. Details are set out below:

PROJECT REPRINTS: These cost 80c per issue-reprint. Thus, a project spread over three issues will cost $2.40. Reprints are available for all projects, but no material can be supplied additional to that already published. Reprints can be supplied more speedily if they are positively identified and not accompanied by technical queries. Material not on file can normally be supplied in photostat form at 40c per page.

SUBSCRIPTIONS, BINDERS, HANDBOOKS etc: These are handled by separate departments. For fastest service, send separate orders to the departments concerned.

PHOTOGRAPHS, METAL WORK DRAWINGS: Original photographs are available for most projects. Price: $1 for 6in x 8in glossy print. Metal work dyelines are available for most projects. Price: $1. These show dimensions and positions of holes and cut-outs, but give no wiring details.

PRINTED WIRING PATTERNS: We can supply transparencies; actual size, positive or negative, as specified. Price: 80c. We do NOT deal in manufactured boards. These are available from advertisers.

BACK NUMBERS: As available. On issues up to six months, face value. Seven months to 12 months, face value plus 5c. Thirteen months or older, face value plus 10c. Postage and packing, 30c per issue extra. Please indicate if a PROJECT REPRINT may be substituted if the complete issue is not available.

REPLIES BY POST: These are provided to assist readers encountering problems in the construction of our projects published within the last two years. Note, particularly, that we cannot provide lengthy answers, or undertake special research or modifications to basic designs. Charge: 80c. Inclusion of an additional fee does not entitle correspondents to special consideration.

OTHER QUERIES: Technical queries outside the scope of "Replies by Post" may be submitted without fee and may be answered in the magazine at the discretion of the Editor. Technical queries will not be answered by interview or telephone.

COMMERCIAL EQUIPMENT: "Electronics Australia" does not maintain a directory of commercial equipment, or circuit files of commercial or ex-disposals equipment etc. We are therefore not in a position to comment on any aspect of such equipment.

COMPONENTS: "Electronics Australia" does not deal in electronic components. Prices, specifications, etc should be sought from appropriate advertisers or agents.

REMITTANCES: These must be negotiable in Australia, and should be made payable to "Electronics Australia". Where the exact charge may be in doubt, we recommend submitting an open cheque endorsed with a suitable limitation.

POSTAGE & PACKING: All charges shown include postage and packing, unless otherwise specified.

ADDRESS: All requests for data and information should be directed to the Assistant Editor, "Electronics Australia", Box 163, Beaconsfield 2014.

Marketplace

FOR SALE

SPECIAL 2N3053 60c; 2N3055 $1.25; 2N3189 75c; 200V 1A diodes 12c; uA709 50c; uA741 90c; SURTRAN Box 317, GPO, SYDNEY.

PRE-RECORDED Cassette tapes! Super quality. Originated for special mail order. Guarantee satisfaction. Free list. Excellent Trading Corp, GPO Box 16424, Hong Kong.

SIEMANS 100 LINE P.A.X. No. 21, complete, in good condition, with instruction manual, circuits, plus quantity of new spares. G. Edwards, P.O. Box 44, Dubbo, 822722 office Hrs.

BUYER REPRESENTATIVE & MAIL ORDER: JFET, transistors, diodes, rectifiers, capacitors, radio parts, TR radio kits etc. prompt delivery. Write for free catalogue to: Radio Electronic Instrument Co., Chesterfield Mansion, 8th fl, Flat C, Kingston Street, Causeway Bay, Hong Kong.

3" EA CALIBRATED CRO — good condition 1 year old — kit cost $140 sell to best offer — PO Box 6, Tolga 4882.

PACKETS OF 160 TRANSISTORS OR DIODES (Untested and ungraded). Cost per packet $2.00 plus P. Post 30c. Send cheques or money order to "Transistors," 22 Mitchell Ave., Boronia 3255.

ORGATRON Large electric reed organ needs repairs $90 or sell cabinet keyboard parts separately. Brisbane 48 3947.

BRAND NEW TRANSFORMERS. 14 volt 3 amps, limited supply, $3.50 each. 27 volt 7 amps $4.00 each. Postage paid if within Australia. Send cheque or money order to: Carr's Electronics, 2 27 Forsyth Street, Kingsford, NSW 2032.

CAR RADIO TUNERS, Manual $3, p button $5. Suit Homodyne tuner, P P 50c. Autoronics, PO Box 661, Orange, NSW 2800.

CAR RADIOS, Galaxy brand, solid state, inbuilt speaker, and installation hardware, $25. P P $1.50. Autoronics, PO Box 661, Orange, NSW 2800.

WE SELL construction plans. TELEVISION: 3 D converter, $25 camera, Kinescoping recorder, VTR COLOUR CONVERTER, HOBBYIST: Electron microscope, 96 hour music system, voice typewriter, Morse code to typewriter, Morse code to typewriter copier, transistorised teletype. TELEPHONE: Answering machine pushbutton dialler, phonevision, Auto dialler, telephone extension in your automobile, legal connector. SECURITY: Microphone jammer, voice scrambler, microdot photography. Plans $5.00, air shipped from our USA research labs. COURSES: Telephone engineering $39.50, security electronics $27.50, investigative electronics $22.50. Super hobby catalogue air mailed $1.00. Payment accepted in dollars (Australian, New Zealand or US). Don Britton Enterprises, Suite 28, 280 Pitt Street, Sydney, Australia.

CITIZEN BAND CRYSTALS. U.S. Ch 1 to 23. N.Z. Ch 4. 455 KHz conversion (suit Sharp, Sony, Midland, Lafayette, Zodiac). 4.225 MHz conversion (suit Sharp CBT72, CBT55, CBT81). Commercial crystals (27 MHz) also available $6.00 per pair including postage. Sharp Corporation of Australia Pty. Ltd., Crystal Division, 22 Burrows Road, St. Peters 2044. Phone: 519 5522.

ALL BACK ISSUES "Electronics Aust.", 50c per copy. Door sales only. T. Weir, 56 O'Connor St., Haberfield, 798 7569. Wanted to buy copies also.

VIDEO TAPES — 12 half inche tapes $15 each — 10 one inch $20 ea Chromium Dioxide 59 1448.

CRYSTALS XTAL 27 240, 26 785, ¼ inch pins — $6.00 per pair post free. P. Shalley, 127 York St, Sydney 2001.

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STOCKTAKING CLEARANCE SALE at **MICRONICS.** Many **PRICES** have been **SLASHED** and New Lines are available. Money Refunded if not Satisfied. **THIS MONTH'S SUPER SPECIALS** are:

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NOTES AND ERRATA

STEREO-24 ADAPTOR (November 1972), **PLAYMASTER 140** (February, 1974): In the printed wiring version of the Stereo-24 Adaptor, the labels "left output" and "right output" are reversed. Since the identity of the synthesised rear signals is largely nominal, the reversal will not prejudice the overall sense of dimension.

PLAYMASTER 137 (Low Cost Stereo) (March 1973, File No 1 SA 41): Plessey Ducon advise that, due to non-availability of the SL403D IC for this project, all kits are now supplied with SL414A ICs. These are a pin-for-pin replacement, the only difference being in the mounting arrangement for the heatsink.

200MHZ DIGITAL FREQUENCY METER (December 1973, 7 F 18): In the wiring diagram on page 41, the board connections shown as coming from the Q and Q-bar connections on the optional overflow board are transposed. The correct connections are as shown in the circuit on page 43.

PLAYMASTER 132 STEREO AMPLIFIER (July 1971, File No 1 SA 36): On page 39, the resistor used for power supply adjustment should be 40 ohms and not 4 ohms as quoted.

DISTORTION from P71

input, it is useful to have a dummy input plug which is short-circuited; if noise persists with this plugged in, it is either internally generated or is getting past the case shielding. An earth connection may be found beneficial, or even essential when using an oscilloscope together with the DV Meter, but do not assume it to be so without trying it — the meter itself will quickly tell you.

With shorted input and a reasonably "quiet" location the self-generated noise is not likely to exceed the equivalent of 0.01pc distortion. For the purist, it seems reasonable to add this amount to the indicated figure to arrive at the true value, but this is perhaps to split hairs in the case of a simplified instrument of this nature. In the prototype the noise approximates 0.008pc distortion.

It is advisable to replace batteries before their voltage falls 20pc, and even new batteries must be watched for noisiness which is far from uncommon in the small units sold for transistor radio sets. If the meter needle begins to show erratic fluctuations even with the input socket shorted, suspect a noisy battery. And beware of buying stale batteries, which can be useless for this instrument even though showing normal voltage. It is best to buy only from sources which have a large and rapid turnover of stock.

An approximate voltage analysis is given to help in trouble-shooting.

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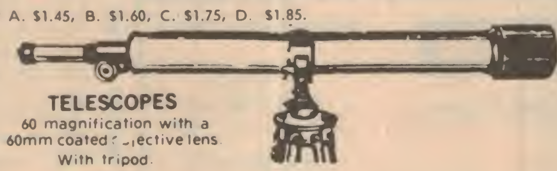

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